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TRAVELS

IN THE

TWO SICILIES,

AND

SOME PARTS OF THE APENNINES.

Translated from the Original Italian of the

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Padua, &c. &c.

IN FOUR VOLUMES.——WITH ELEVEN PLATES.

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TRAVELS

TRAVELS

IN THE

TWO SICILIES, &c.

CHAP. XXIII.

CONSIDERATIONS RELATIVE TO THE ACTIVITY OF VOLCANIC FIRES.

Two contrary opinions concerning this activity; many naturalists imagining that it must be very great, and others that it is extremely weak--The arguments favourable to the former opinion examined—First argument deduced from the effects produced by the fire of a lava in motion, compared

with thoſe of common fire—Heat of this lava when it is diſgorged from the ſubterranean caverns greater than that of our furnaces—Second argument, derived from the promptneſs with which cold lava is liquefied when thrown upon melted boiling lava, which cannot be obtained by common fire unleſs it be extremely powerful—The retention of a ſtrong heat by lavas long after they have ceaſed to flow adduced as the third argument in favour of the great activity of volcanic fires—Fourth argument derived from the fuſion of large maſſes of ſtones, and conſiderable tracts of country by rivers of lava flowing over them—Fifth argument deduced from the great difficulty with which the fuſion of the volcanic glaſs of Iceland is obtained in common fire—The boiling of the waters of the ſea in conſequence of volcanic conflagrations a ſixth argument of the great efficacy of the latter—The ſeventh and laſt argument derived from the great fluidity of lavas in many circumſtances—The arguments, on the contrary, employed to prove

that

that the activity of the fires of volcanos is extremely feeble, may be, in fact, reduced to one only; that is, that those fires produce no essential change in stones which have passed into lava, and are incapable of fusing shoerls; whereas the fire of our furnaces destroys by vitrification the primordial characters of these stones, with, commonly, a fusion of the shoerls—This argument more specious than solid; since it may be proved that it is not always true that volcanic fires are insufficient for the fusion of shoerls; as they sometimes melt the garnets of Vesuvius, which are refractory in our furnaces; and that the little or no alteration of the primordial characters in lavas is not to be ascribed to the feebleness of these fires, but to their manner of acting, which is different from that of common fire—The fire of the furnace sufficient to fuse rocks, whether volcanic or not volcanic; but incapable of producing in them true fluidity—A fire of much stronger temperature necessary for this—Enquiry how far the opinion of some can be maintained,

that the fire of volcanos produces its effects rather by the duration of its action than by its activity—The fire of our furnaces, remaining conſtantly the ſame for a few days, is incapable of fuſing ſtones; yet in a greater number of days will produce fuſion in them; but at the ſame time it deſtroys their texture, in the ſame manner as it would be deſtroyed by a fire of greater activity. Enquiry whether ſulphur acts as a flux on the ſtones which paſs into lava, or facilitates their fluidity; and the negative concluded from a long ſeries of facts—Proof, likewiſe, from numerous and certain obſervations, that there is little or no foundation for the opinion that flowing lavas, beſides the caloric (heat) which they receive from the volcanos, contain likewiſe a caloric of their own, which, after the manner of inflammable bodies, is developed by a true combuſtion—Neceſſity of acknowledging that we have not clear and diſtinct ideas of volcanic fires—Our uncertainty relative to the nature of their aliment, and the manner in which

they

they act independent of the concurrence of atmoſpheric air—Oxygenous gas, probably, the cauſe and preſervative of ſubterranean conflagrations, and capable of producing ſingular combinations in the ſtony bodies it inveſts, when mixed with other gaſes and ſaline ſubſtances—Poſſibly water united to fire may contribute to produce ſuch combinations.

THE terrible and ſtupendous ſcenes of globes of flame and fiery ſtones forced to a prodigious height, of mountains melted by violent heat, and rivers of burning lava, which in every age have preſented themſelves to the aſtoniſhed eyes of men, have induced an almoſt general belief that the power of theſe deſtructive fires is much greater than any of which our common fire can furniſh us an idea. This opinion, which always has been, and continues to be, that of the common people, and which has been embraced by many celebrated naturaliſts, would certainly at preſent be the

prevailing, or rather the only one, were it not that within theſe few years another, directly oppoſite to it, ſince it ſuppoſes the activity of volcanic conflagrations to be extremely feeble, has been advanced and defended by ſome profeſſors of natural ſcience. Both parties are, in fact, ſo fully perſuaded of the truth of their reſpective opinions, that, while producing the arguments which appear favourable to their hypotheſes, they appear to think it unneceſſary even to liſten to the objections and reaſons of their antagoniſts. I ſhall conſider it, however, as my duty, in examining this difficult and intereſting controverſy, my ſole object being truth, to ſtate fully and impartially the arguments on each ſide of the queſtion. I ſhall therefore firſt give thoſe which are or may be adduced to prove the powerful activity of volcanic fires; and next thoſe in ſupport of the contrary doctrine: accompanying each with ſuch reflections as appear to me to ariſe out of the ſubject.

Argument I. As the intenſity of common fire

fire is measured by the effects it produces in the bodies on which it acts, it is evident that we must employ the same rule to measure that of volcanic fires. And, as we have seen that the pyrometer of Wedgewood is the most certain measure of these effects in common fire, it is indubitable that this instrument would afford the best means of ascertaining the activity of the heat of volcanos; and in Chap. I. of this work I pointed out a method by which it might be easily employed for this purpose in certain circumstances of the flowing lava.

Attempts have, however, been made by other, though less certain methods, to ascertain the degree of heat in lavas. I find such an experiment to have been made by some academicians of Naples in the famous eruption of Vesuvius in the year 1737, on a lava near the Torre del Greco, which, though it had ceased to flow for some days, still retained, in a bottom in which it had collected, a redness similar to that of red-hot

iron *. The following was the result of the experiments then made on the ſtrength of the fire of this lava.

A piece of lead, of a conical form, two ounces in weight, being placed on the red-hot ſurface, after two minutes and a half became ſoft, and after three and a half was entirely melted. Another piece of lead, of the ſame figure and weight, was then placed on a red-hot plate of iron, laid over burning coals, when the metal did not begin to liquefy till after ſix minutes and a half, and was not entirely melted till ſeven minutes and a half.

Water placed on that lava, in a copper veſſel, began to ſimmer at the end of three minutes, and, in the fourth, boiled furiouſly. When a ſimilar experiment was made with an equal quantity, in the ſame veſſel, placed over burning coals, it began to ſimmer

* Vide Serao, ubi ſup.

ſtrongly

ſtrongly in four minutes, and in the fifth boiled violently.

From theſe experiments Profeſſor Serao infers that the power of the fire of that lava, though deprived of a part of the heat it had when ſoft and flowing, much exceeded that of burning coals or red-hot iron.

I cannot but commend theſe experiments, principally becauſe they are among the very few that have hitherto been made to aſcertain a compariſon between our common fire and that of volcanos. But though I can ſuppoſe that the heat of the lava exceeded that of red-hot coals, I cannot admit that it was greater than that of red-hot iron. The plate of which the Academicians made uſe, being ſurrounded on every ſide by the cold air, could not have that heat it would have retained in other circumſtances. The glaſs furnace is inadequate to melt iron in the maſs; but it will render it of a moſt violent red heat. But a cone of lead of the weight of two ounces, being placed on a

plate

plate of iron that had continued half an hour in this fire, was completely melted in leſs than one minute.

As this lava, however, had not flowed for ſome time, it muſt have loſt no ſmall quantity of its heat: hence, to obtain a more preciſe and adequate compariſon, it was neceſſary to make experiments on it in the ſtate of liquidity. This, partly by accident and partly by human induſtry, has been done. Among the prodigious deſtruction cauſed by a deluge of liquid matters, that which it occaſioned in the convent of the Carmelites was not the leaſt. The above-cited Neapolitan phyſician informs us that the fiery torrent entering that edifice, beſides reducing to aſhes the combuſtible matters, that were even at ſome diſtance from it, melted the drinking-glaſſes on the table of the refectory, reducing them to one ſhapeleſs maſs.

We find a confirmation of this accident in the Engliſh Philoſophical Tranſactions, in a paper given in by Prince Caſſano, a mem-

ber

ber of the Royal Society, in which he relates that the torrent, after having fired the door of the church of the Carmelites, the windows of the ſacriſty and refectory, melted the glaſs veſſels that were upon the table. He here adds an experiment of importance, which is, that *a piece of glaſs fixed to the end of a pole, and approached to the fluid matter, was reduced to a paſte at the end of four minutes.*

This fact is corroborated by the following related by Profeſſor Bottis, in his deſcription of the conflagration of Veſuvius in 1667. His words are theſe: "In the middle of "the ſame lava edifices were ſeen, ſome of "which the lava had ſurrounded without "injuring them; others it had broken and "ſhattered, burning every thing before it. "In ſome of them the flames from the tor-"rent of fire had melted ſome large glaſs "veſſels which ſtood above, where the "ſtream could not reach them."

On conſidering theſe facts, we cannot

admit that the firſt of them, that is, the liquefaction of the drinking-glaſſes enveloped in the flowing lava, can be a convincing proof of its great activity, ſince we know that factitious glaſſes will melt more or leſs in our common fires. On the latter two of theſe facts, though to me they appear of leſs importance, I ſhall make ſome remarks. I imitated in ſome manner the experiment of the Prince di Caſſano, relative to the fuſion of glaſs approached to burning lava, by holding, in a pair of pincers, a piece of glaſs an inch in thickneſs, ſuſpended in the air of a glaſs-furnace. In a few inſtants it began to ſoften, and, in a minute, to flow, forming a long deſcending thread. The efficacy, therefore, of this fire exceeded that of the fire of the lava in queſtion, at leaſt in the circumſtances of this experiment. But here ſeveral particulars are to be remarked. According to the account in the Philoſophical Tranſactions, the glaſs was approached to the flowing matter: it therefore did not touch it. It cannot be doubted but that, had it touched, it would more eaſily have

fuſed.

fuſed. Beſides, when this lava reached the convent of the Carmelites, it muſt have loſt a conſiderable part of its heat, and that principally from two cauſes—Firſt, becauſe it had flowed over a long tract of ground, and, conſequently, had communicated its heat, as well to the air immediately in contact with it, as to the ground over which it had paſſed: Secondly, becauſe, when near the mouth whence it iſſued, it formed one ſingle wide ſtream, which, as it proceeded, branched off into ſmaller channels; and this diviſion muſt greatly have diminiſhed the activity of its heat. From theſe conſiderations it is evident that the heat of the lava, where the experiment was made, was greatly inferior to that it poſſeſſed when it was firſt diſgorged from the mountain, which was probably much greater than that obtained in common glaſs-furnaces.

Argument II. The above-mentioned Profeſſor Bottis, deſcribing the eruption of Veſuvius, which began on the 29th of July 1779, and continued to the middle of Auguſt

guſt following, relates that, on the 10th of September in the ſame year, making a viſit to the mountain, " he obſerved a ſmall hill, " formed of ſpongy ſtones, and ſurrounded " by lava recently ejected ; in which hill, he " adds, was a ſmall gulph, of a figure almoſt " circular, about three palms in diameter and " two in depth. From this gulph proceeded " a low noiſe, ſimilar to that of oil or any " fat ſubſtance ſimmering over the fire, " which ſound was, no doubt, produced by " ſubſtances fuſing in it. Its fire was ſo " ſtrong that, ſome ſpongy ſtones being caſt " into it, they immediately became red-hot, " and melted, producing the appearance of " boiling pitch."

This obſervation is of conſiderable importance in the preſent enquiry. Whoever is acquainted with the works of M. Bottis relative to Etna, will immediately perceive that by *ſpongy ſtones*, he means porous lavas, and the *ſcoriæ* of that mountain. In my experiments, I found that theſe do not require a continuance of leſs than half an hour

to

to ſoften them. If, therefore, the gulph into which theſe ſtones were thrown liquefied them like boiling pitch, it is evident that its heat greatly exceeded that of the furnace. I found on uſing a reverberatory furnace, of a high temperature, that it required a heat equal to that requiſite to melt iron, to obtain a ſpeedy fuſion of theſe Veſuvian products, and, in general, of thoſe of other volcanos. It is likewiſe equally evident that this ſmall gulph, communicating from above with the cold air, muſt there be leſs ſtrong than in its internal part, ſince that narrow mouth was only a ſpiracle or vent-hole to that great maſs of lava, which boiled and flamed in the deep receſſes of the mountain.

Argument III. The preſervation of a ſtrong heat in lavas which for ſome time, and, frequently, for a great length of time, have ceaſed to flow, may be conſidered as another proof of the vehemence of their heat, when they were fluid. The above-mentioned Profeſſor Bottis obſerves that the

lava

lava of the year 1737 croſſed a public road, and that, a month afterwards, labourers being employed by the order of the King to remove it, they were obliged to deſiſt from the attempt, becauſe the internal maſs ſoftened the iron inſtruments they uſed to break it. When not far from the higheſt crater of Etna, I croſſed a lava which had flowed eleven months before, and was entirely detached from the volcanic furnace; I found it, notwithſtanding, in ſome apertures, retain a red colour, which was very conſpicuous to the eye in full day-light; and a ſtaff being put upon it immediately ſmoked and took fire *.

Sir William Hamilton let fall ſome pieces of wood into the fiſſures of a lava, and they immediately took fire, though that lava had no communication with the volcano, and was full four miles diſtant from the mouth whence it had iſſued.

The lava of the great eruption of Etna

* See Chap. VIII.

in

in 1669, after eight years, had not become cold, in many places, according to the obſervations of Maſſa, a Sicilian writer.

Theſe facts, compared and combined, furniſh, in my opinion, another luminous proof of the powerful heat of volcanos. It is true that, eruptions uſually occupying a great extent of ground, that extent cauſes them to preſerve their heat longer; but it is equally true that, whatever may be the volume of the lavas, their heat would not be ſo great after ſuch long intervals of time, were it not prodigiouſly more powerful at the time they flowed.

Argument IV. Fazello, the Sicilian, begins the deſcription of an eruption of mount Etna, which happened in 1536, with theſe words: "IX calend. Aprilis, flante auſtro, "et ſole ad occaſum vergente, nubes atra "montis apicem operuit, et inter eam rubor "emicuit; tum repente, ex ipſo cratere, ig-"nei torrentis vaſta vis erupit; paullatim-"que in modum fluminis, magno montis

" murmure ac terræ motu defluens, in ori-
" entem verſus deſcendit, lacumque illapſus
" magnam ibi repertam lapidum congeriem
" liquefecit." On the 23d March, nearly about the time of ſun-ſet, the ſouth wind blowing, a black cloud, in the midſt of which a kind of redneſs appeared, covered the top of the mountain; when, ſuddenly, a prodigious fiery torrent burſt from the crater, and, flowing like a river down the eaſtern ſide of the mountain with a great noiſe and ſhaking of the earth, poured into a lake, where it melted a large quantity of ſtones that were amaſſed together.

This obſervation having been made at a time when accuracy and preciſion were not poſſeſſed by all obſervers, I muſt ingenuouſly confeſs that I ſhould ſuſpend my faith relative to the liquefaction of this great maſs of ſtones, if I did not find it wonderfully confirmed in the deſcription given by Mr. Pennant of a lava that iſſued from a volcano in Iceland, in 1783. After deſcribing the prodigious extent of country that this lava covered,

covered, he remarks the perpendicular height of the ſides of this current was from 80 to 100 feet; overwhelming not only all the villages that it found in its way, but likewiſe many hills: thoſe that were too high to be thus ſubmerged it melted; ſo that the entire ſurface of the country was in a ſtate of fluidity, and formed a lake of fire, reſembling a maſs of melted metal.

I leave the reader to judge of the aſtoniſhing activity of this conflagration.

Argument V. Iceland alſo furniſhed another proof of the activity of its volcanos. We have ſeen that the glaſſes of the Eolian Iſles, and thoſe of the Phlegrean Fields, eaſily fuſe in the furnace. As I did not poſſeſs any ſpecimen of the Icelandic glaſs, I could not make any experiments upon it; but Bergmann, who had this advantage, obſerved, that he could not obtain a fuſion of it with the blow-pipe: whence he concludes, that the fire which formed it muſt be extremely powerful.

Argument VI. Vallisneri, in his description of the new volcanic island which rose from the sea in the vicinity of Santorine in 1707, mentions, amongst other events which happened at that time, a circumstance of great importance to the present enquiry. At the time this island emerged from the waves, the sea round it was greatly agitated, and had acquired such an immoderate heat that it boiled, and the boiling extended to a considerable distance; by which a great quantity of fish was destroyed. We read the same fact in the travels of the Marquis de Choiseul, taken from a history of that time, in which it is likewise remarked that the pitch of some ships was melted.

This fact appears to me a sufficient proof of the violence of the fire of that volcano, since to heat to such a degree so enormous a mass of sea-waters, and that in a place so deep, presenting so large a surface, and surrounded, as they are, by cold waters, certainly required a very great development of the matter of heat.

A won-

A wonderful phenomenon of the ſame kind was alſo obſerved there in the ages of antiquity, according to Strabo *, who ſays that between Thera and Theraſia the ſea was ſeen to boil for four days. We have ſeen that Santorine conſiſts of a prodigious maſs of pumices, which ſtones have been thrown up from the bottom of the ſea by the action of volcanic fire †. From the analyſis I made of two pumices of that iſland, it appears that their baſe was the aſbeſtus ‡. I know not whether the baſe of the other pumices of that place be of the ſame or of another ſtone; but in either caſe the two pumices that I analyſed prove that the fire, by the action of which the aſbeſtus paſſed into pumice, muſt be extremely powerful.

Argument VII and laſt. This is derived from the fluidity of the lavas. It is incon-

* *Αναμεσον Θηρας και Θηρασιας, εκπεσȣσαι φλογες εκ τȣ πελαγȣς εφ' ἡμερας τεσσαρας, ωςε πασαν ζειν και φλεγεσθαι την θαλασσαν.*

† See Chap. XIX.

‡ See Chap. XV.

teſtable that a greater or leſs degree of heat muſt occaſion a greater or leſs degree of fluidity. We ſhall ſpeak preſently of that degree of fluidity which lavas acquire in the furnace: we ſee that it is greater in a fire of high temperature, and it is ſtill more increaſed when we employ oxygenous gas. Theſe gradations of fluidity have, likewiſe, place in every other ſtone, as well as in a thouſand other ſubſtances fuſible in the fire. The reaſon is very evident, ſince the more the particles of a fuſible body ſeparate from each other by the interpoſition of a fiery fluid, the more complete is the fuſion. If, therefore, we prove a great fluidity in the lavas, we ſhall alſo prove a proportionate violence in the fire. This we ſhall now make the object of our enquiry; in which it will be impoſſible to be very brief, however we may wiſh for brevity, both from the variety of intereſting facts to be adduced, and the remarks by which they muſt neceſſarily be accompanied.

To preſerve ſome kind of order, we will divide theſe facts into two claſſes; the firſt conſiſting

conſiſting of ſuch as have relation to thoſe lavas which are ſeen to ſpout up like water from volcanos, thoſe which are found to retain ſoftneſs after having been thrown through the air, and thoſe which have been obſerved to boil within the craters.—In the ſecond claſs we ſhall place ſuch facts as relate to thoſe kinds of lavas which, iſſuing from craters, or the ſides of volcanos, and extending in long currents, have permitted obſervers to meaſure their velocity, and the degree of fluidity or ſoftneſs they have acquired.

With reſpect to the former, two obſervations of Profeſſor Bottis are worthy attention—the firſt relative to a circumſtance obſervable in the eruption of Veſuvius in 1771, and the ſecond reſpecting another that took place in the eruption of the ſame volcano in 1776. After having related that, by the ſide of the aperture whence the torrent of lava iſſued, four low hills ſuddenly roſe at once, he remarks, that from three of theſe, which were in the form of cones, the fire

(that is to ſay, the ignited lava) ſpouted out from ſome ſmall openings near their tops, preciſely in the ſame manner as water when it is forced out through narrow channels or apertures. The curves which the inflamed fluid, iſſuing from theſe hills, deſcribed in falling, were of various dimenſions. They all three threw up fire at the ſame time, and were, in fact, three beautiful and real fountains of fire.

From this fact Profeſſor Bottis infers, that the fire of Veſuvius is very powerful; and immediately adds, "I have twice ſeen at a ſmall diſtance from it the inflamed matter break forth and diſgorge in the *Atrio del Cavallo*. From its great fluidity it reſembled water iſſuing with violence from under the earth, and inundating the circumjacent country.

The ſubſtance of his other obſervation is, that Veſuvius, in the beginning of the year 1776, having poured from its ſummit a torrent of lava, it ſtruck upon the lava of

1771,

1771, and rebounded into the air, congealing in ſmall branches of various figures, terminating in thin ſharp points like needles; as he obſerved the day after, when he aſcended the mountain. Hence he remarks, that *this matter muſt have been extremely fluid, as that uſually is which is ejected from the mouth of Veſuvius.*

We will now ſay a word of that ſoftneſs which, ſometimes, though rarely, the pieces of lava retain after they have been thrown through the air from the mouths of volcanos, and fallen on the ground. An inſtance of this is related by the ſame M. Bottis, which is ſo extraordinary that I ſhould doubt the fact, were not the relater a perſon highly worthy of credit; and had it not been witneſſed by thoſe illuſtrious and eminent perſonages, his Royal Highneſs Maximilian Archduke of Auſtria, his Eminence the Count de Wilzeck miniſter plenipotentiary, his Eminence Cardinal Herzan, and Sir William Hamilton, with ſeveral others of rank and learning.

When lavas are thrown up from volcanos in the form of a fiery hail, before they reach the earth they have commonly already acquired the hardneſs of ſtone, from the ſtrong impreſſion of the cold air; which, acting on pieces of ſuch ſmall dimenſions, in a few moments deprives them of all fluidity. I had a favourable opportunity for obſerving this when I was at the mouth of the volcano of Stromboli, and protected, as I have already deſcribed, from the fury of its ejections; notwithſtanding ſeveral globes of lava fell very near me. On examining ſome of thoſe that had fallen, I found them indeed ſtrongly ignited, and at the ſame time as hard as ſtones.

Very different was the fact which occurred at Veſuvius, when, at break of day on the 19th of June 1775, the above-mentioned illuſtrious ſpectators obſerved it near its ſummit. The volcano, then, ejected a quantity of liquefied ſtones. As one of theſe fell, one of the guides ran ſpeedily to it, and, with the point of a ſtaff, perforated

it

it from ſide to ſide, and preſented it, with the ſtaff thus paſſed through it, to the Archduke; who ſo much admired this extraordinary phenomenon, that he ordered the perforated lava, which weighed about eight pounds, to be preſerved, together with the ſtaff, in his private cabinet. If, therefore, that fragment of lava, of ſo ſmall a ſize, remained ſtill ſoft, notwithſtanding the continual contact of cold air, it is a ſtrong argument that within the crater it was extremely fluid. It muſt, however, be acknowledged that, even at Veſuvius, ſuch phenomena are extremely rare, and are probably produced by an action of the fire more powerful than ordinary; for, if melted ſtones, when thrown from volcanos, had the ſoftneſs and pliability of paſte at the time they ſtruck the mountain, it is evident they muſt be beaten in by the blow, and take more or leſs of a flat ſhape; which is contrary to experience. At leaſt, among thoſe pieces of lava that Veſuvius ejected when I was there, and of which I collected ſeveral, I obſerved that they all inclined to

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the orbicular figure, without any ſenſible flattening *; and, in making the tour of the mountain, I found innumerable others which had been thrown out before, of a ſimilar ſhape. Beſide thoſe of Stromboli, I obſerved the ſame conformation in various ſtones of Etna thrown out in the eruption of 1787 †.

We will now proceed to adduce an inſtance of the great fluidity of the lavas burning within the craters. Of this we have two obſervations of no common kind, made by the above-cited Profeſſor, an indefatigable enquirer into the nature of the eruptions and other ſymptoms of the volcano in his vicinity.

" The ſame night the mountain exhibited " an extraordinary ſpectacle: a hollow noiſe " was heard from time to time, after which " a great quantity of extremely fluid fiery " matter overflowed the edges of the mouth,

* See Chap. I. † See Chap. VIII.

" which

" which firſt inundated almoſt the whole " neck of the mountain, and, then, divided " into various ſerpentine rivulets of fire, " which ran rapidly down its ſides, and, " after ſix minutes, or nearly ſo, became " extinguiſhed. This was repeated at in- " tervals, during the ſpace of three hours, " the ſame night." We find this in his account of the conflagration of Veſuvius in 1767.

In his account of that in 1779, he uſes the following compariſon—" As a liquor " which boils in a veſſel riſes and overflows " the edges of that veſſel from the violence " of the heat; thus, frequently, from the " grand mouth of the mountain, the great " quantity of extremely fluid fiery matter " iſſued, in almoſt every part, and pour- " ed down its ſides, deſtroying all before " it."

Theſe two obſervations, which evidently demonſtrate the extreme fluidity of the lava when

when boiling in the crater of Veſuvius, correſpond exactly with what I myſelf obſerved in the two craters of Etna and Stromboli; nor can I doubt but the ſame facts are obſervable in the effervescent matters of other volcanos.

According to the order which I have preſcribed to myſelf, I ſhall now proceed to ſpeak of thoſe rivers of lava which pour forth from volcanos, and, frequently, dividing into ſeveral branches, ruſh down the ſides of the mountain, continuing their motion to a great diſtance. As their velocity is often very conſiderable, it may be concluded that their fluidity, and conſequently the activity of the fire, muſt be ſo likewiſe. The ſtream of lava that iſſued from Veſuvius, in the eruption in 1751, flowed over the ſpace of twenty-eight palms in a minute.

In the eruption of the ſame volcano in 1754, the lava formed two branches which flowed

flowed thirty feet in forty-five seconds, and, uniting lower down, proceeded at the rate of thirty-three feet in fifty seconds.

To these two observations, which are by Father Turre, I shall add two others from Sir William Hamilton. The first relates to the eruption of the same mountain which happened in 1765, in which he remarks that the progress of the lava was at the rate of about a mile an hour. His second observation respects another branch of the same eruption, of which he does not determine the precise velocity; but it must have flowed with great rapidity, as he tells us he is sure that, for the first mile, the velocity of this torrent was equal to that of the river Severn, at the passage, near Bristol.

The Marchese Galiani, in his Observations on Vesuvius, writes that, in the year 1631, about ten at night, on the 17th of September, a lava was seen flowing from the upper mouth of the mountain, which in three hours after had already entered the sea,

ſea, within which it formed three very long promontories; a proof, as he juſtly remarks, of the aſtoniſhing velocity of theſe lavas.

I cannot conclude without mentioning another obſervation, on the ſame ſubject, from M. Bottis. On the firſt iſſuing of the lava from Veſuvius, in the year 1767, its velocity was ſo great, that ſome perſons who were near the place had ſcarcely time to make their eſcape.

In 1771, a dreadful torrent of lava ruſhed from the mountain; which, when it reached the *Canale dell' Arena*, had traverſed, within an hour, the ſpace of fifteen hundred Neapolitan *canne* *.

In the eruption of 1776, Veſuvius threw out from its ſummit a torrent of lava which flowed a mile and a half in fourteen minutes. The Abbate Franciſco Ferrara, of

* The Neapolitan *canna* conſiſts of eight Neapolitan palms, and a Neapolitan palm is nearly one ſixth ſhorter than a Paris foot.

Catania,

Catania, who obſerved, on the ſpot, the eruption of mount Etna in 1792, informed me that the lava of that eruption advanced at the rate of a pace for every ſtroke of his pulſe, which, he added, was very quick.

Theſe examples are ſufficient to ſhow the great velocity of lavas. It is neceſſary, however, to remember that I have choſen theſe inſtances from among thoſe in which its velocity was greateſt. Many others might be adduced, in which it is moderate, and others in which it is extremely ſmall. In general, however, this velocity may be increaſed or diminiſhed from many cauſes. Where the declivity, down which the lavas deſcend, is great, they move more ſwiftly, and *vice verſa*. Their courſe alſo will be more rapid, the nearer they are to the oriſice whence they iſſued. In general, lavas, in any of the above-mentioned circumſtances, either do not move at all, or move very ſlowly, if they are not preſſed forward by new ſupplies of melted matter. Hence, very frequently, a torrent of lava that has

but juſt iſſued from the volcano, will ſtop, even on a ſteep declivity, from a failure of new matter preſſing upon it, and compelling it to proceed.

To return to my principal ſubject; it may be remarked that, were we deprived of the obſervations mentioned above, which ſhow the great fluidity of lavas in certain circumſtances, their exterior velocity might lead us into an error; ſince it is well known that the tenacity and conſiſtence of lavas is very great, even when they flow with the greateſt rapidity.

Sir William Hamilton, deſcribing the Veſuvian lava of the year 1765, which flowed at the rate of a mile an hour, tells us its conſiſtence was ſuch, that it almoſt reſiſted any impreſſion of a long pole; and that ſome large ſtones, thrown into it with great force, did not ſink, but, making only a ſlight impreſſion, ſwam upon its ſurface.

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In my excurſion to Veſuvius, I remarked a ſimilar reſiſtance in the lava which ran underground through a narrow channel, into which great ſtones being thrown with force, ſank only to one third of their bulk, and then were carried away by the current. In another broader torrent of this lava that flowed in the open air, large ſtones, thrown in like manner, made no impreſſion *.

Dr. Serao affirms that many perſons have frequently ſtruck the external parts of lava, when it was in actual motion, with long ſtaves, and found it ſo hard that it reſounded with the blow.

Bottis informs us that, in the Veſuvian conflagration of 1770, a learned friend of his, ſeeing a ſtream of that eruption flowing rapidly (he deſcribes it as paſſing the ſpace of forty palms in one minute), attempted to aſcertain its fluidity. With that intent, he

* Some of theſe facts have already been ſtated in Chap. I; but it was neceſſary to repeat them here to compare them with others.

took a ſtaff, and endeavoured to force it into the liquid burning matter; but, contrary to his expectation, he found it reſiſting and tenacious, and perceived that the ſtaff had ſcarcely entered it, though he had thruſt it with all his force.

I am not, therefore, greatly ſurpriſed when I read that ſome perſons have paſſed over the lava in motion, without receiving any injury. M. Jamineau, Engliſh conſul at Naples, having gone, with ſome others, in 1754, to obſerve an eruption of Veſuvius, one of the guides, coming to a ſtream of lava which moved ſlowly, found no difficulty in running over it. Sir W. Hamilton had the courage to do the ſame, though in ſome meaſure compelled by neceſſity, in the great Veſuvian eruption in 1779. He was then near a ſtream of lava which flowed ſlowly, and was from between fifty to ſixty feet in breadth, when he found himſelf ſo incommoded by the heat, and the ſmoke which the wind blew upon him, that he would have been obliged to return, without

ſatisfying

ſatisfying his curioſity, if the guide had not propoſed to him to croſs the lava itſelf as ſwiftly as poſſible. The propoſal being accepted, the guide paſſed over without any great difficulty, and was followed by the Engliſh naturaliſt, and by another Engliſh gentleman who accompanied him, none of them experiencing any other inconvenience than exceſſive heat in the feet and legs.

The above-cited Marquis Galiani, and other perſons of reſolution, paſſed in the ſame manner over currents of lavas actually in motion.

This tenacity and reſiſtance of lavas, even when flowing, is a conſequence, as is evident, of the action of the cold atmoſphere, which, coming in contact with the ſurface, deprives them of ſo much heat that they loſe their former fluidity. This loſs of heat is, however, incomparably greater on the ſurface than in the internal parts; where the lava ſtill retains a conſiderable degree of fluidity, as appears on breaking the cruſt

that covers it. M. Jamineau, above cited, though he remarks that the external coat of the lava, obſerved by him, was ſo hard that the heavieſt ſtones made no impreſſion on it, found, at the ſame time, that the internal maſs might be eaſily penetrated by a ſmall ſtick. Father Torre, in like manner, in the eruption of Veſuvius in 1754, having broken the external cruſt of a branch of lava which no longer flowed, a fluid boiling matter iſſued from the orifice.

But there is no fact more memorable, or more appoſite to the preſent ſubject, in the hiſtory of volcanos, than that related by Borelli in his account of the eruption of mount Etna in 1669. An impetuous river of lava, diſgorged from Monte Roſſo, having deſtroyed all the villages and fruitful fields it met in its way, was ready to riſe above the walls of the illuſtrious city Catania. In theſe dreadful circumſtances ſome of the inhabitants conceived a bold expedient to ward off from their houſes this threatening torrent of fire. With hammers

and

and other ſuitable inſtruments, they made an opening in the ſide of the lava, the ſurface of which was already hardened, ſo that the internal matter, which ſtill continued fluid, might iſſue out and take its courſe in another direction.

This bold attempt was crowned by the moſt complete ſucceſs; ſince, the external cruſt being broken laterally, the matter, which ſtill remained fluid, poured out, and flowed to a conſiderable diſtance, on that ſide to which it was thus turned. It is difficult to ſay by what fatality the ſame expedient was not had recourſe to in other caſes of ſimilar neceſſity.

Though the velocity, therefore, of the external parts of lavas may be conſidered as an inconcluſive proof of their fluidity, this fluidity will be very evident when we obſerve the internal; and, in certain eruptions ſuch as that laſt mentioned, it muſt be owned to be extreme. This Etnean lava flowed the diſtance of more than fourteen

miles, from the baſe of Monte Roſſo to the ſea. Scarcely had it iſſued from its ſource, when it loſt all communication with the internal volcano: and though, from the cruſt which formed over it, it preſerved more or leſs of its heat, that muſt neceſſarily diminiſh continually, in proportion as the lava deſcended, removed to a greater diſtance from its ſource, and, inſtead of one ſingle trunk which it formed at firſt, was divided into ſeveral branches; and ſucceſſively and uninterruptedly communicated a part of its heat to the internal ſides of the channels in which it flowed.

If, therefore, notwithſtanding this conſtant loſs of heat, the lava remained liquid and flowing, for the ſpace of fourteen miles, how great muſt have been its fluidity when it firſt iſſued from the Etnean furnáce!

But this is not the greateſt diſtance to which the lavas of mount Etna have flowed; as we know that others have run eighteen, twenty, and even, ſometimes, thirty miles.

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In the eruption mentioned by Sir W. Hamilton, which I likewiſe obſerved, the lava that iſſued from the higheſt crater flowed to the diſtance of fifteen miles, and plunged into the ſea at Taormina.

Since the conflagrations of volcanos have been recorded in hiſtory, I know no eruption more remarkable, for the extent of ground occupied by it, than that of Iceland in the year 1783, mentioned above; which, from the account we have received of it, dried up twelve rivers, and extended ninety-four miles in length and fifty in breath. It is impoſſible to conceive that lava can inundate ſo vaſt a tract of country, without ſuppoſing its fluidity, at leaſt in its external parts, to have been very great. Whether, therefore, we conſider the lavas iſſuing from fiſſures of volcanos like guſhing waters, or preſerving a great degree of ſoftneſs though divided in fragments and ſurrounded by the cold air, or boiling and foaming within their craters, or precipitating like rivers down the declivities

declivities of the mountains, it is indubitable that, in all theſe circumſtances, they muſt poſſeſs, at leaſt when they firſt break forth from the volcanic mouths, a very great fluidity, which fluidity can only have been produced by a proportionate heat.

Theſe are the arguments, in my opinion, the ſtrongeſt and moſt convincing that can be produced in favour of the activity of volcanic conflagrations—We will now conſider thoſe which are alleged on the other ſide, to prove that this activity is very ſmall. Theſe may conveniently be reduced to one alone; which is founded on the conſideration that no deſtruction of the original character, or eſſential change, takes place in ſtones or rocks, which have paſſed into the ſtate of lava by the action of volcanic fires. The firſt naturaliſts who advanced this opinion were M. Sage, and T. A. Deluc, who, from obſerving ſome of our furnaces vitrify lavas much more perfectly than volcanos, and that they melt ſhoerls, which are found untouched

touched in the lavas, inferred that the fire of our furnaces was ſuperior in activity to that of volcanos.

M. Dolomieu has endeavoured ſtill more to diminiſh this activity, on which he has made ſome obſervations, in almoſt all his works. In his " Travels to the Lipari " Iſlands," after having ſaid that ſome lavas at Saline extremely reſemble porphyry, having nearly the ſame colour, the ſame conſiſtence, and the ſame feltſpar ſpots; he deduces as a conſequence from it, that the volcanic fires, in liquefying ſtones, do not at all change their natural texture; and that the fuſion of lavas is very different from that produced in our furnaces, in which all the ſubſtances we ſubject to the experiment loſe their figure by vitrification. In a long note which he has added relative to the Etnean lava in 1669, and the ſhoerls and feltſpars which were found within it uninjured, he endeavours to prove, that the fire of volcanos acts only as a diſſolvent; that it dilates bodies, and inſinuates itſelf within the

the particles, ſo that they ſlide one over the other, and, when it is diſſipated, leaves the different ſubſtances nearly as it found them. Hence he compares the action of volcanic fire with that of water in the ſolution of ſalts, which participate the fluidity of the diſſolvent, and reſume their concrete form by evaporation.

In his introduction to his "Deſcriptive "Catalogue of the Products of Etna," he repeats the ſame obſervation, and remarks the incapability of volcanic fire to vitrify ſhoerls, though in themſelves eaſily fuſible, whence he concludes *that the fire of volcanos is not intenſe.* He ſhows likewiſe that it is incapable of altering the texture of ſtony baſes; even when it liquefies them.

That the reader may form a clear idea of the opinion of this ingenious French naturaliſt, I ſhall cite the following paſſage from a Memoir he has recently publiſhed on Baſaltes: "I ſhall again repeat what "cannot be too frequently inculcated, that

"lavas

" lavas are not vitrifications ; their fluidity " is ſimilar to that of metals reduced to fu- " ſion ; it does not change the order, and " manner of being, of the conſtituent parts " of the lavas. When they ceaſe to flow, " they reſume, like metals, the grain, tex- " ture, and all the characters of their primi- " tive baſe ; effects which we cannot pro- " duce upon ſtones in our furnaces, ſince " we know not how to ſoften them by fire " without changing the manner in which " they are aggregated. The fire of volcanos " has not that intenſity which is ſuppoſed, " and produces its effects rather by the ex- " tenſion and duration of its action, than by " its activity *."

We have here the argument on the contrary ſide placed in its full light. Among the various reaſons which induced me to ſubject volcanic productions to the furnace, one was, that I might obſerve the changes produced in them by common fire : I con-

* Roſier, Journal de Phyſique, t. xxxvii. an. 1790.

ſtantly

ſtantly found that the characters of the primordial rocks were deſtroyed by vitrification, and the ſhoerls, if not always, very frequently fuſed. When treating of the Euganean lavas, which abound in micas and feltſpar, we have ſeen that both theſe ſtones frequently melt in the ſame fire. Laſtly, it appears from many parts of this work, that only rocks and ſtones not volcanic fuſe in the furnace, without loſing their characteriſtic lineaments. The facts therefore adduced to prove the weakneſs of volcanic fires are unqueſtionable, and have a very ſeducing appearance. We will now ſtate the argument on this ſide of the queſtion in its whole force.—The fire of volcanos is leſs efficacious and powerful than our common fire, if it leaves untouched, or little altered, the ſtructure of the rocks it fuſes, when this ſtructure is deſtroyed by the fuſion occaſioned by common fire.—The fire of volcanos is leſs efficacious and powerful than our common fires, if it is incapable of producing the fuſion of the ſhoerls, feltſpars, and micas, which may be effected by common

common fire. But both theſe propoſitions have been proved by the facts adduced— Therefore, &c.

I will candidly confeſs, that, having continually before my eyes lavas, including ſhoerls and feltſpars, retaining their primitive texture, and finding them to be ſo changed as to be no longer known after refuſion in the furnace, my whole attention being then directed to theſe objects of compariſon, I have more than once been inclined to believe that the fire of the furnace was more energetic than that of volcanos; and this opinion I have not concealed in ſeveral parts of this work.

Having, however, afterwards carefully attended to what has been written both for and againſt this activity, the aguments in its favour appear to me to have much more force than thoſe on the other ſide. I do not however deny but that there are caſes in which the activity of volcanos may be but moderate and even ſmall; this depending, in

in fact, on the greater or leſs development of caloric (heat) collected in their fiery gulphs.

With reſpect to the little or no alteration which takes place in the primitive texture of the rocks changed into lava, and the infuſibility of the ſhoerls and feltſpars, I think they are both to be aſcribed not to the feebleneſs of theſe fires, but to their manner of acting, which is probably different from that of common fire, and hitherto not ſufficiently known to us. On examining the degree of heat neceſſary for the fuſion of certain lavas, and that of the ſhoerls they contain, in common fire, I have obſerved that the baſes of ſeveral melt with a leſs degree than is required for the fuſion of their ſhoerls; but that the baſes of others require a greater degree; ſo that, in ſome caſes, that degree of heat which melts the ſhoerls, is inſufficient to fuſe the baſe of the lavas within which they are included: yet, in theſe latter, volcanic fires have produced a quite contrary effect, having fuſed the baſe

of the lavas, and left the ſhoerls in them untouched.

In Chap. XVI. we have remarked the infuſibility of the Veſuvian garnets in the furnace, and the great difficulty of fuſing them in a heat of the higheſt temperature. Yet, in many lavas with a horn-ſtone baſe, theſe are found half vitrified by the fires of Veſuvius, with the entire vitrification of the ſhoerls, as has been ſhown by the Chevalier Gioeni, in his *Lithologia Veſuviana*. M. Joinville found ſome garnets in the lavas of Cività-Caſtellana, which were fuſed together with their ſhoerls *. In Chap. III. I have given a deſcription of theſe garnets, which I collected on the ſpot, and have remarked that they reſembled the Veſuvian. They are found partly with a lava of a horn-ſtone baſe. I collected a conſiderable number of them, and found that the aſſertion of M. Joinville was very true; as among many that were untouched and cryſtallized, there

* Roſier, Journal de Phyſique, an. 1788.

were ſome that were vitrified, and amorphous. It was remarkable that the lava which contained them, though in ſome ſmall degree vitrified, had not loſt the characters of the horn-ſtone. The experiments I made ſhowed that the garnets of Cività-Caſtellana were equally infuſible in the furnace with thoſe of Veſuvius, notwithſtanding their baſe was completely vitrified in the ſame fire.

Theſe facts prove, Firſt, that it is not always true that volcanic fires are inſufficient for the fuſion of ſhoerls. Secondly, by the vitrification of the garnets, they confirm the powerful activity of thoſe fires. Thirdly, that thoſe fires operate in a manner in ſome meaſure unknown to us; ſince, at the ſame time that they vitrify the garnets, they leave the baſe in which they are included in a ſtate perfectly recognizable, notwithſtanding that the former are refractory to the fire of the furnace, while the latter is eaſily fuſible.

It is alſo eaſy to ſhow, by other means, that the compariſon between the fire of our common furnaces and that of volcanos, which is adduced by the oppoſers of the activity of the latter fires as their ſtrongeſt argument, is extremely fallacious; ſince, taken in another point of view, they prove directly the contrary. In the obſervations and experiments I have made on lavas, we have already ſeen that they almoſt all fuſe in the furnace, forming in the upper part of the crucible either a horizontal, a depreſſed, or a riſing ſurface. It has, likewiſe, been remarked that many lavas, in refuſion, flow over the edges of the crucible, and form ſtreams down its ſides. From obſerving the facility with which lavas fuſe in the furnace, and the manner in which they overflow the crucible, I concluded that in this ſtate they muſt be extremely fluid; but what was my ſurpriſe when I found their complete liquefaction accompanied with an unexpected tenacity and conſiſtence! When they had remained in a ſtate of

fuſion for ſeveral hours in the crucibles, ſo that ſome of them actually boiled, when I attempted to immerge into them vertically a pointed iron wire, I could ſcarcely, with all my force, plunge it to the bottom; and, in ſome, it did not penetrate more than three or four lines. When I took away the iron, the impreſſion it had made likewiſe remained, though the crucibles ſtill continued in the furnace during the experiment, and was filled up by the liquid matter, till after nine or ten minutes. And, when I took the crucibles with a pair of iron tongs, and inverted them within the furnace, the melted lava did not flow out; though, in a quarter of an hour, or nearly ſo, a thread of lava would ſlowly deſcend from the inner edge, which could ſcarcely be detached with another pair of tongs.

Theſe experiments, the reſults of which I conſidered as very extraordinary, I repeated on a larger ſcale, fuſing the lavas in capacious clay receivers. I then endeavoured

voured to perforate them with ſharp iron wires, and tried the effects of inverſion, without finding any ſenſible difference.

Nor did I omit to make ſimilar experiments on thoſe lavas which it is known were extremely fluid when they firſt iſſued from the ſides of the volcanic mountains; ſuch as the lava of Etna, which flowed, in 1669, to the diſtance of fourteen miles; that which precipitated into the ſea near Taormina, after having flowed thirty miles; and ſeveral others of the ſame immenſe mountain, which had formed very long currents.

While employed in theſe curious experiments, from which I found ſuch unexpected reſults, I reſolved to try whether, by continuing the lavas a long time in the furnace, they might not loſe their great tenacity and conſiſtence, and become, at length, extremely fluid, and ſuch as they were when they were diſgorged from the volcanic mouths. I therefore continued ſeveral lavas, and ſome of thoſe volcanic glaſſes which

become extremely full of bubbles, in the furnace, for forty days. The conſequence was, that the maſs of every lava and volcanic glaſs was greatly diminiſhed in the crucible by evaporation; the bubbles in the glaſſes, as alſo in ſome of the lavas, were in a great degree deſtroyed, though ſome had acquired a greater number of thoſe bubbles. The vitrification, therefore, of theſe bodies had become more perfect and more pure; but ſo far were they from having acquired greater fluidity, that the pointed iron wire ſcarcely made any impreſſion upon them.

I afterwards proceeded to make experiments on theſe lavas in a much more powerful fire than that of the glaſs-furnace; I mean a chemical reverberatory furnace. In this, the lavas became much more ſoft. They were reduced to the ſtate of a ſoft paſte. The pointed iron penetrated them, and the cavity it made was preſently filled. On inverting the crucibles, the lava flowed out of them in the ſame manner as pitch would have

have flowed, when not entirely melted by the fire.

I afterwards employed oxygenous gas, putting ſmall pieces of ſeveral lavas on burning coals, excited by that efficacious agent. The lava then became red-hot almoſt in an inſtant, took the form of a globule, and, on inclining the coal on which the globule reſted, flowed like water.

On ſubjecting certain ſtones not volcanic to the action of theſe three different kinds of fires; I found in them the ſame reſiſtance in the common furnace, the ſame ſoftneſs in the reverberatory furnace, and the ſame fluidity when oxygenous gas was employed.

The learned reader muſt immediately perceive the conſequence to be deduced from theſe experiments. If the fire of the glaſs-furnace, though it fuſes lavas and rocks not volcanic, does not render them truly fluid, to effect which a conſiderably more

powerful heat is neceſſary ; and if this fluidity (which I do not ſay is to be compared to that of water, but which it is neceſſary they ſhould poſſeſs when they flow) is produced in theſe rocks by volcanic fire ; it ſurely cannot be doubted that this fire is far more powerful than that of the glaſs-furnace.

But here it is neceſſary to recollect that the heat of the furnace, beſides vitrifying the lavas, fuſes the ſhoerls and feltſpars which remain untouched in that of volcanos, though we have proved that the latter is more active : an argument which, in my opinion, concluſively demonſtrates that the infuſibility of theſe ſtones is improperly aſcribed to the want of activity in the ſubterranean conflagrations.

Though, from the numerous facts adduced, it appears to me evident that the fluidity of a lava flowing down the ſides of volcanic mountains is the effect of an igneous fluid with which it is copiouſly penetrated,

trated, I ſhall not omit to conſider two arguments produced by M. Dolomieu, to prove that lavas may flow, without the action of a violent heat. His opinion is, firſt, that *the fire of volcanos* (as has been before mentioned) *produces its effects rather by the duration of its action, than by its activity.* It is, he ſuppoſes, very feeble, and therefore incapable of changing the rocks, or fuſing the ſhoerlaceous and feltſpathoſe cryſtallizations; but by being a long time applied to them, it ſeparates their particles, and cauſes them to flow. In the ſecond place, the ignited ſulphur, of which volcanos are never deſtitute, muſt, according to him, greatly promote this fuſion.

To aſcertain the force of theſe arguments I made ſeveral experiments. As the French Naturaliſt has ſuppoſed that the volcanic fire, though feeble, may by long continued action render fluid the ſtony ſubſtances it inveſts, without altering their original ſtructure, I wiſhed to try the reſult of leaving ſome ſtones for a long time in ſuch a degree of

of heat, as was insufficient to fuse them in a time moderately short. The glass furnaces of Pavia were very convenient for such an experiment, since the degree of heat in them is, to every appearance, the same, during the whole time that the melted glass remains in them; that is, five-and-forty days; and is only made somewhat more intense during the fifteen following days, in which they melt and work the crystal glass.

This equality of heat is proved first by the practical observation of the workmen. The melted glass in the *padelle*, or large clay vessels in which it is contained, is susceptible of greater or less liquidity, according as the fire which acts on it is more or less intense. If its liquidity be too great, it is unfit to be worked, because it will not adhere to the iron tubes employed to blow it; and if it be not sufficiently liquefied, it is equally unfit, because it cannot be blown. A moderate degree of liquidity is therefore necessary, which the workmen are able to obtain,

by

by a determinate degree of fire, which they continue always the ſame. Beſides that they know this mean liquidity by the touch, they can likewiſe diſcern it by the ſight alone; the glaſs then having a clear light red colour, which becomes an extremely lively white, ſcarcely ſupportable to the eye, when the fluidity is too great; and, on the contrary, a dark dull red, when it is too little.

I was not, however, ſatisfied with this rule, to aſcertain the equality of the heat; but to obtain a more preciſe and determinate proof it, I had recourſe to the pyrometer of Wedgewood. I placed four clay cylinders in their caſe, in that part of the furnace where I made my experiments on the ſtones: two of them I took out after two days, and let the other two remain, during the whole time the melted glaſs remained, that is, five-and-forty days; when on meaſuring, and comparing the contraction of the two former with that of the two latter, I could not diſcover the leaſt difference.

difference. I was therefore phyſically certain, that the heat had continued the ſame during the whole of that interval of time.

The ſtones employed in theſe experiments were of thoſe kinds which had been found refractory in the furnace, after a continuance of two or three days; that is, ſome feltſpars in the maſs, and ſome petroſilices; though other congenerous ſtones, in the ſame circumſtances of time and place, had been fuſed. I added to them the fix pitch-ſtones, mentioned in Chap. XX. which were not in the leaſt liquefied, after continuing eight-and-forty hours in the furnace; as alſo the ſilex, or red flint, of the Cava della Battaglia in the Euganean mountains, mentioned in the ſame chapter. Theſe ſtones, eighteen in number, were thus left in the furnace, in a heat conſtantly equal. I carefully obſerved them from day to day, to notice what changes might take place in them; but to give a prolix journal of the remarks I made, would probably only tire my readers. It appears ſufficient, for my preſent

preſent purpoſe, to ſtate the final reſult, with a few remarks on ſome particular circumſtances. I ſhall ſay, therefore, that there were none of them which were not more or leſs vitrified; in ſome, the vitrification had commenced after the eleventh day, in others before, and in others after. The pieces of ſome ſtones had adhered together, without forming a united whole; in others, the fuſion had been general. The vitrification in theſe experiments took place very ſlowly; firſt appearing as a very thin coat or cruſt, which afterwards became thicker, and at length, in ſome ſpecies of theſe ſtones, penetrated to the centre. This glaſs gives fire with ſteel; is compact, extremely pure, tranſparent, and colourleſs, or at leaſt very ſlightly tinged with green, light yellow, or ſky-blue. The flint of the Euganean mountains was more refractory to vitrification. It is true, that after the third day of their continuance in the furnace the pieces began to adhere together, but on the twenty-fifth the vitreous coat with which they were ſurrounded was ſcarcely two lines in thickneſs;

and

and when taken out of the furnace at the end of the forty-five days, the nucleus of ſome pieces of flint exhibited a ſimple calcination. The ſame was the caſe with two pitch-ſtones, notwithſtanding a complete fuſion had taken place in the other four.

The glaſs-furnace in which I made theſe experiments could be of no further uſe to me, as I have before ſaid, after the forty-fifth day, the fire being then increaſed for the making of cryſtal glaſs. But ſoon after, another of the ſame kind was kindled: two furnaces being every year employed at Pavia, the workmen who have worked in one remove to the other, and very nearly the ſame degree of heat is maintained in both. I reſolved, therefore, to transfer from the firſt to the ſecond furnace, thoſe ſtones that internally were not completely vitrified, which were thus continued forty-five days more, or, in the whole, ninety days, expoſed to the ſame degree of heat. This prolongation of an equal heat was not inefficacious, the vitrification being ſtill further

ther extended by it in the nucleus of the pitch-ſtones, and the flint; nor can I doubt but it would have been complete, had the ſame heat been continued for a longer time.

Theſe experiments were very inſtructive. Before I made them, when I ſaw that a continuance in the furnace of a few days was inſufficient to fuſe ſtones, I have been uſed, in this work, to call them refractory to the furnace, or infuſible; and, in fact, ſuch they appeared during that time. I was then ignorant of the effect that might be produced by a longer duration of equal heat. Experience has now taught me, that this infuſibility may be overcome by the continuance of the ſame heat; ſo that it is now proved, that a long continued heat of leſs ſtrength is equally efficacious in the fuſion of bodies, with a ſtronger heat of a ſhorter duration.

After a little reflection on the inefficacy of fire, for the fuſion of ſtones, when its duration is only for a few days, and its power

power to produce that effect after longer continuance, it appeared to me, that the nature of this difference might be eaſily explained. This agent at firſt only calcines ſtones, depriving them of ſome of their parts, and more or leſs altering their ſtructure; but, continuing to act on them, it no longer finds them in their former ſtate, but in part changed; whence its action produces new combinations. In the mean time, other changes take place by the loſs of other particles that are volatilized, and hence other modifications ariſe, from which the ſtone at laſt acquires the conditions of beginning fuſion. If then a more active fire be applied, it will effect, in a ſhort time, what the leſs active can only effect after a longer continuance.

If we proceed to apply theſe facts to the poſition advanced by M. Dolomieu, that the volcanic fire acts more by its duration than by its ſtrength; we ſhall ſee that this fire, though it ſhould be feeble, may, in a long time, liquefy thoſe ſtony bodies, on which

it would not have that effect, if it were of ſhort duration; but this liquefaction would be accompanied likewiſe with that of the ſhoerls and feltſpars, and the deſtruction of the ſtructure of thoſe ſtony bodies. Such effects at leaſt I have obſerved in the above-mentioned ſtones. Should it be objected that this obſervation is not applicable to volcanos, ſince the matters ejected from the crater of Stromboli, though they inceſſantly fall back into it again, and are expoſed to a long action of its heat, do not loſe their primitive characters*; I ſhall anſwer, that though this be allowed, it will not prove the want of activity in volcanos, but rather the ſingular manner of their acting on the ſubſtances with which they meet; as we have ſhown above, and ſhall again have occaſion briefly to ſhow hereafter.

To proceed to the ſecond argument of M. Dolomieu, relative to the ſulphur, I obſerve that, in many parts of his works, he

* See Chap. XI.

conſiders this inflammable body in volcanos as a true flux; and, at page 157 of his *Deſcriptive Catalogue of the Productions of Etna*, has theſe remarkable words: "A "ſtone, extremely ferruginous, being heated "red-hot and brought in contact with a roll "of ſulphur, an effect takes place nearly "ſimilar to that produced on a piece of "iron, which, in the ſame circumſtances, "burns, calcines, and becomes inſtanta- "neouſly fluid, by the action of the ſul- "phur on it."

I ſhall here relate the methods I employed to aſcertain whether ſulphur facilitates the fuſion of thoſe ſtones which uſually are the baſe of lavas; ſuch as horn-ſtones, petro-ſilices, and ſhoerls in the maſs. I choſe ſuch of theſe as do not require a long time to begin to fuſe in the furnace, endeavouring to prove, by ſome comparative term, whether ſulphur facilitated their fuſion. I cauſed, therefore, ſix crucibles to be made of clay, each a foot and a half in height, ſeven inches wide at the bottom, but narrower

rower towards the top, where they terminated in an aperture of a line and a half in diameter, having there the form of an inverted funnel. One of theſe I filled to the top with petroſilex reduced to powder; and the other to three quarters of its height with ſulphur in powder, filling the remainder of the crucible quite to the top with pulveriſed petroſilex. I filled the other four crucibles, in like manner, with horn-ſtone, and ſhoerl in the maſs, one of each with, and one without ſulphur. I was thus enabled to obſerve the manner in which theſe ſtones will fuſe in the furnace both with and without ſulphur. The ſulphur I employed could not be better adapted to the experiment, ſince it was that of the iſland of Vulcano. It muſt be evident that it was neceſſary each of the ſix crucibles ſhould be expoſed to exactly the ſame degree of heat, and of this I certified myſelf by means of the clay cylinders.

After thirteen minutes the ſulphur began to exhale from the three crucibles which

 contained

contained it, in the form of a thin expanding ſmoke, of a reddiſh colour, which aroſe from the three funnels. I had purpoſely left that narrow aperture in the crucibles, ſince, had they been entirely cloſed, the ſulphureous exhalations would have burſt them; and, beſides, by the narrowneſs of the aperture, the inflammation of the ſulphur was more preſerved. The fumes increaſed, and continued for a conſiderable time, and ſtill remained when the hornſtone in the crucible without ſulphur, as well as in that which contained it, began to fuſe; which it did after fifty-three minutes. I did not perceive that the ſulphur in the leaſt accelerated the fuſion.

I obtained a beginning fuſion of the petroſilex in the crucible without ſulphur after ſixty minutes, nor did I find that it took place ſooner in the other crucible which contained ſulphur, and which continued to fume for fifty-eight minutes. On breaking the two crucibles, I did not perceive any difference in the vitrification of the petroſilex.

In theſe two experiments, therefore, the ſulphur had not accelerated the fuſion of theſe two ſtones, nor could I diſcover that it did that of the third.

As it is the opinion of many that ſulphures of iron are the aliment of volcanic fires, and that the ſulphur which ſublimes from them thence derives its origin, I determined to repeat the ſame experiments in ſix ſimilar crucibles, making uſe of ſulphure of iron inſtead of ſulphur.

This ſulphur was in a ſtate of decompoſition, and abounded with the ſulphuric acid. The fact however was, that the fuſion of the above-mentioned ſtones took place as ſoon in the three crucibles without ſulphur, as in the three others that contained it.

It has been mentioned above that M. Dolomieu tells us that, if a piece of ſulphur be touched with a red-hot ſtone, abounding

in iron, this ſtone, like iron in the ſame circumſtances, becomes fluid in an inſtant.

I had now an inviting opportunity to make an experiment with lavas when in actual fuſion within the crucibles, ſelecting ſuch as moſt abound in iron. We have ſeen that lavas, in general, never acquire, in the furnace, a true fluidity, but only a greater or leſs degree of liquidity. It is evident that, if the aſſertion of the French naturaliſt were well founded, this liquidity muſt paſs into fluidity in theſe ferruginous lavas when ſulphur is burned on them. While, therefore, they were in a ſtate of actual fuſion in the furnace, I cauſed to be dropped into the crucibles liquid and burning ſulphur, by means of an iron ladle, which, having a long handle of the ſame metal, might be introduced into the furnace. At the ſame time that the liquid and burning ſulphur was thus poured into the crucible by another perſon, and when all the melted lava was covered with it, while it

boiled

boiled over it, and ſublimed in a thick reddiſh fume, I, with a pointed bar of iron, tried the reſiſtance of the lava to obſerve whether, as the melted ſulphur was dropped on it and evaporated, the ſurface acquired greater liquidity. But no ſuch effect took place. The ſame degree of reſiſtance it manifeſted before the ſulphur was poured into the crucible, continued when it was poured in, though this pouring was continued a quarter of an hour; and it remained the ſame after the ſulphur had entirely evaporated.

I made theſe experiments on ſeven kinds of lavas, and always with the ſame reſult, with reſpect to the ſulphur being the cauſe or promoter of the fluidity of the lavas.

As the burning ſulphur, though aided by the fire of the furnace, was incapable to promote the fuſion of theſe ſtones, it might very reaſonably be ſuppoſed incapable to fuſe them when it acted on them by its flame alone, animated by a current of air, in

a chemical furnace, as I likewiſe found by experiment. This flame, in fact, produced no greater effect, when animated by oxygenous gas produced by the mixture of two thirds of flowers of ſulphur with one third of nitre.

From the reſult of theſe experiments there appears no foundation to believe that ſulphur can act as a flux on the ſtones that paſs into lava, or that it facilitates their fluidity.

I ſhall now proceed to a brief examination of another opinion of M. Dolomieu relative to the fluidity of lavas. It may be reduced to this: That lavas are penetrated by two kinds of caloric (heat): the one communicated to them in the volcanic gulph; the other proper to themſelves, and which is developed by a real combuſtion; that, in conſequence of this ſecond caloric, their fluidity laſts much longer than it would if they had only that received from the volcano: whence we may underſtand why ſome

lavas

lavas pass over only a very small space in a long time; and that the combustion of lavas sometimes resembles that of urinary phosphorus, and at others produces a true flame, which in many cases is a clear blue, or variously coloured.

It is evident that the existence of such a combustion is principally supported by the effects which are supposed to be produced by it; I mean the variously coloured flame, which M. Dolomieu tells us appears on the surface of running lavas. Had this respectable Naturalist been an eye-witness, I certainly should not have disputed his assertions. But he only speaks in general, and in a vague manner; and I cannot doubt but, had he seen it, he would have described it circumstantially, to give greater proof to so novel an hypothesis. It is true, he promises, in his Introduction to his *Products of Etna*, to prove his assertion by a series of observations; and his work, when published, will certainly be eagerly read by all naturalists. In the mean time, as a sincere

lover

lover of truth, he cannot be offended if I adduce ſome facts that do not accord with the ſuppoſition of this flame. I have extracted them from authors who have ſeen flowing lavas a hundred times, and have deſcribed their phenomena with the moſt ſcrupulous exactneſs, and without the leaſt appearance of prejudice: theſe are, Serao, Father Torre, Bottis, and Sir William Hamilton.

The firſt, ſpeaking of the lavas from time to time ejected from Veſuvius, remarks, that "when ſeen by night at any diſtance, they "emit a light, not ſhining, like a bright "flame, but of a dead kind, like that of "red-hot ſubſtances which burn without "flame." When deſcribing circumſtantially the lava ejected from the ſame volcano in 1737, he does not mention a word of its flame.

Father Torre, relating the principal circumſtances of the eruption of Veſuvius in 1751, remarks, that "there was no viſible "fire

" fire on the ſurface of the torrent." And deſcribing the moſt minute phenomena of the other flowing lavas, he makes no mention of flames proper to them, nor does he ſay that he ſaw them burn; only in pages 75 and 76 of the work I have ſo frequently cited, he ſays, " On obſerving by night " the ſurface of the lava, even in thoſe places " where it was become cold, flames of ſul- " phur were ſeen to iſſue in many places, " which immediately became extinguiſhed." But beſides that this lava no longer burned, the flames which appeared proceeded from ſulphur; and theſe are frequent in volcanos, but have no relation to the preſent queſtion.

If we open the quarto volume of Profeſſor Bottis, entitled, *A Hiſtory of the various Conflagrations of Mount Veſuvius**, we ſhall find ſcarcely a page in which we do not meet with the deſcription of ſome burning lava; but though I have attentively examined that work, I do not find a ſingle

* Iſtoria di varj Incendj del Monte Veſuvio.

paſſage

paſſage in which mention is made of flames attendant on running lavas. It is true, the author frequently uſes the terms *inflamed torrent*, *rivers of fire*, *&c.* but theſe are emphatical expreſſions, and ſuch as I have frequently employed myſelf; by which he certainly only means currents of lava profoundly penetrated by fire.

Sir William Hamilton, who approached very near the mouth of Veſuvius at the time of a violent eruption, does not ſay that the lava flamed, but only, that "it had "the appearance of a red hot and liquid "metal, ſuch as we ſee in the glaſs-houſes."

With reſpect to the flames which ſometimes appear on lavas, he ſays, "I have "obſerved upon mount Veſuvius, that ſoon "after a lava has borne down and burned "a tree, a bright flame iſſues from its ſur-"face; otherwiſe I have never ſeen any "flame attending an eruption." And here he obviates the miſtake which might ariſe from taking for the flame of a lava the

ſmoke

ſmoke iſſuing from it, which by night has all the appearance of it.

The obſervations I made at Veſuvius, Stromboli and Etna, do not in the leaſt differ from thoſe of the four naturaliſts above mentioned. In my deſcription of a lava moving within a cavern of mount Veſuvius, I have ſaid " its ſurface exhibited the red-" neſs of burning coal, but without the ſmall-" eſt appearance of flame*." I have noticed ſimilar appearances in two other caverns of the ſame mountain; and ſpeaking of the lava which flowed above the ground, I remark that " it had a red colour, but leſs " ardent than that of the lava which flowed " within the cavern†."

In the boiling lava of the crater of Etna, I likewiſe ſaw no flame: it only had the appearance of " a liquid ignited matter‡."

* Chap. I. Vol. I. p. 12, 13.

† Ib. page 24.

‡ Chap. VIII. Vol. I. p. 249.

But

But the furnace of Stromboli, eſpecially, afforded me the moſt favourable opportunity to diſcover this flame; both from my very near approach to the aſcending and deſcending lava, and from my having obſerved it entirely at my eaſe during the night. It is certain, however, that I ſaw no appearance of any flame, which I have not neglected to notice to the reader. The following are my words: "The ſurface of the burning "lava within the crater never emitted any "ſenſible flame, not even when the bubbles "upon it burſt with an exploſion; but it "ſhone with a glowing vivid light, and re-"ſembled in its appearance melted glaſs in a "furnace*."

I know that, to prove this combuſtion, M. Dolomieu refers to a lava of Etna which flowed ten years, and only advanced one mile. But I ſhall firſt obſerve, with his permiſſion, that the diſtance flowed by this lava was not one mile, but two. Such at

* Chap. X. Vol. II. p. 65.

leaſt

leaſt is the account of Alphonſus Borelli.—
" Deinde, anno 1614, nova vorago ſupra
" oppidum Tyſſæ ſeu Rondatici aperta eſt,
" e qua effluxit pariter materia ignita curſu
" tam lento et torpido, ut intra decem annos,
" quibus perpetuo effluxit, duo tantum mil-
" liaria pertranſierit."—" Afterwards, in the
" year 1614, a new gulph opened above the
" town of Tyſſa or Rondatici, from which
" iſſued a fiery matter, with a courſe ſo
" ſlow and heavy, that in ten years, which
" it continued to flow, it only paſſed over
" a ſpace of two miles."—Secondly, it appears to me, that we may conceive the cauſe of the extreme ſlowneſs of this lava, without ſuppoſing, with the French Naturaliſt, that it burned, and therefore continued to flow ſo long as the aliment of combuſtion remained in it. It is certain that the velocity of lavas depends, among other cauſes, on the greater or leſs declivity of the ſurface down which they deſcend; and if a current is forced along a horizontal plain; and ſtill more if it is compelled to aſcend, as ſometimes happens in mountainous places,

its

its courſe will be extremely ſlow; and this may have been the caſe with the lava of 1614. This flowneſs of its motion may likewiſe have been cauſed by the great diſperſion of the heat received from the volcano, which might, in conſequence, have become ſo weak as ſcarcely to retain the lava in a ſtate of fluidity. Laſtly, for I will not omit a remark I conſider as of importance, if this principle of combuſtion were intrinſic to the rocks, and developed itſelf in open flame in their fuſion, it is evident that the ſame phenomenon would accompany the liquefaction of theſe rocks in the furnace, in which, however, I never perceived the leaſt ſign of combuſtion or flame.

Theſe obſervations, it appears to me, muſt prevent us from receiving with confidence the hypotheſis of the French volcaniſt, relative to the flame produced in lavas, according to him, by a combuſtible ſubſtance they contain, and which burns and conſumes in the manner of other inflammable bodies.

bodies. He muſt, at leaſt, permit me to conſider it as abſolutely doubtful and uncertain until he ſhall produce facts ſufficient to demonſtrate its truth.

Relative to the fires of volcanos, therefore, I conſider two things as certainly proved: Firſt, the great activity of the greater part of them: Secondly, that their manner of acting has been hitherto little known to us, and, perhaps, will never be clearly underſtood. Their energetic force has been demonſtrated by numerous and ſolid arguments, which have not been in the leaſt invalidated by thoſe adduced on the contrary ſide; as the difficulties objected in the latter may be eaſily explained by the ſingular manner in which theſe fires act, and of which we have convincing proofs. To theſe proofs I ſhall here add a new one.

When I was at Naples, I obtained ſome ſpecimens of that Veſuvian lava which was obſerved by Profeſſor Bottis fuſed and boiling within a ſmall cavity, and which he

found to be penetrated with ſo great a heat that it ſuddenly liquefied ſcoriæ and porous lava which he threw into it. I have ſtated this fact in Argument II. in favour of the great activity of volcanic fires. On examining theſe ſpecimens, I ſoon perceived, from their preſerved ſtructure, that the baſe of this lava was a horn-ſtone; and the cryſtallized ſhoerls it included exhibited in their fracture that vividneſs which is the property of thoſe ſtones when uninjured. But both theſe ſhoerls and the lava, after a continuance of ſome hours in the glaſs-furnace, became glaſs. How, then, can we explain why theſe bodies ſhould remain untouched in a moſt violent fire, and vitrify in one leſs ſtrong, without ſuppoſing that the energy of the former was combined with certain circumſtances and principles tending to preſerve their ſtructure, but with which we are hitherto unacquainted?

I have thought that ſulphurs and petrols give birth to and maintain volcanos, as has been the opinion of the generality of naturaliſts.

raliſts *. It muſt, however, be confeſſed, nor do I fear to be contradicted, that ſuch an opinion is very hypothetical, ſince we are ignorant what really is the aliment of ſubterranean fires. It is certain that this aliment, whatever it may be, is, when it burns, in very different circumſtances from thoſe of our furnaces, which cannot burn without the preſence of atmoſpheric air, of which the ſubterranean abyſſes, where volcanic conflagrations begin, are deſtitute. The iſlands that have been produced by the action of ſubmarine volcanos are almoſt innumerable; and new ones have been thrown up even in our times; as, for example, the two which aroſe in the Icelandic ſea, in 1784, in a part where the water was five hundred feet deep. How, then, can we reaſonably ſuppoſe the exiſtence of our air at this prodigious depth below the ſea, where the ſubſtances productive and alimentary of volcanos take fire? We muſt deſpair of ever underſtanding the nature of theſe fires, or

* See Chap. XI.

admit the development of oxygenous gas, which we have ſeen elſewhere is not improbable *. Were this gas pure, the fire, animated by it, would vitrify the whole, and form one homogeneous maſs; but with how many heterogeneous ſubſtances muſt it not be united, from which combination probably reſult its ſingular, and, by us, little underſtood operations, which manifeſt the moſt powerful activity, at the ſame time that it leaves uninjured the bodies it fuſes! Numerous, and very different from each other, are the aëriform fluids which, no doubt, exiſt in theſe receſſes; ſuch as the carbonic acid gas, the muriatic, hydrogenous, and azotic acids, &c. ſince of theſe volcanos are never deſtitute. It is evident that ſuch fluids will, more or leſs, modify the virtue of oxygenous gas, from which will ariſe proportionate modifications in the fires animated by it, and in the ſtones on which they act. The ſalts they meet with, and which we frequently find adherent to

* Chap. XXI.

the

the mouths of volcanos, ſuch as the ſulphates of alumine and iron, and the muriates of ammoniac and ſoda, it is probable, likewiſe, concur to produce ſuch modifications. It is true that different ſaline ſubſtances facilitate the vitrification of ſtones; but we know not what products may ariſe from the ſimultaneous combination of various ſalts, eſpecially if they ſuffer decompoſition in the burning volcanic gulphs.

It is not improbable that water united with fire may produce combinations impoſſible to be attained by human art. This was the opinion of Faujas; who was convinced that there was a kind of myſtery in the elaboration of the products of volcanic fires, when compared with thoſe produced by our common fire. I ſhall here tranſcribe his remark on this ſubject, and conclude this chapter with the authority of that juſtly celebrated volcaniſt: "I almoſt incline to "be of opinion that the aqueous fluid, raiſed "to a degree of ebullition and incandeſcence "of which our feeble furnaces can give us no

" idea, ſometimes concurs with the inactive
" and concentrated fire which exiſts in the
" immenſe volcanic caverns, and that from
" this concurrence reſult a multitude of
" combinations hitherto unknown to us,
" which take effect on the ſtones and earths
" that remain perhaps whole ages in theſe
" burning gulphs, where the fire, intent to
" deſtroy, has for its adverſary the water,
" which inceſſantly creates and oppoſes to
" it all the forms and modifications of which
" the matter is ſuſceptible."

CHAP.

CHAP. XXIV.

CONCLUSION OF THE ACCOUNT OF THE EOLIAN ISLES, IN REMARKS ON VARIOUS SUBJECTS NOT VOLCANIC.

I. Lipari.—*Population of that iſland—Uſeful vegetables produced in it; among which the vine furniſhes the moſt conſiderable branch of its commerce—Celebrated malmſey of this country—Manner of making that wine—Scarcity of corn, which might be rendered more plentiful by adopting a different ſyſtem of agriculture—Great abundance of Indian figs in Lipari and the other Eolian iſlands—Delicious taſte of their fruit—Deſcription of that ſhrub; and remarks on the facility with which it may be multiplied—Project to render it much more profitable by making uſe of its leaves to nouriſh the cochineal inſect, as*

ſilkworms are fed with the mulberry leaf—Fiſhes and coral found near the ſhores of Lipari—Account of a phyſeter, or kind of whale, obſerved by the author in that ſea—This fiſh, though internally organized nearly like others of the mammalia claſs, could remain under water a much longer time than they uſually can—Very few cattle of any kind in Lipari—Cauſe of this ſcarcity—Rabbits the only wild quadruped in this iſland—Manner of hunting them with the ferret—Stationary birds at Lipari but few; nor any birds of paſſage, at leaſt at the time the author was there—Some which with us are birds of paſſage, there ſtationary——Curious manner of taking ſwallows, in the ſtreets of the city, in winter—Branches of foreign commerce which have begun to be introduced at Lipari within theſe few years—Remarks on the aſſertion of Strabo, Diodorus, and Dioſcorides, that Lipari derived a conſiderable profit from the ſulphate of alumine (alum)—Political and eccleſiaſtical ſtate of Lipari—Phyſical

—Phyſical and moral character of the Lipareſe—Brief account of the city of Lipari.

II. Stromboli.—*The great heat felt in this iſland not to be attributed to its volcano, but the ſun—Nature of this climate—Frequency of tempeſts—The ſhore of Stromboli deſtitute of a harbour—Veſſels uſed by the natives to navigate theſe ſeas—The great quantity of fiſh taken in the vicinity of this iſland, probably a conſequence of the heat of its volcano—Plants which grow in this iſland—Malmſey the principal product of the country—Vines, and the manner in which they are defended from the wind—Number of inhabitants—The natives not fearful of their volcano—Hoſpitality of the Strombolese—Their character—Account of a ſpring, the only one in the whole iſland—Animals found in Stromboli.*

III. Vulcano.—*An uninhabited iſland—Great quantities of ſulphate of alumine (alum)*

(alum) once extracted here—Difficulty of the extraction of it at present—More profit might be derived from planting vines.

IV. Saline.—*Abundance of grapes in this island—Spring near the shore, probably supplied by rain water—Muriate of soda (sea-salt) extracted from a small lake contiguous to the sea—Means of procuring this salt—Curious phenomenon observable in this lake, when the sea water enters it.*

V. VI. Felicuda and Alicuda.—*Their population—The houses built, not on the shore or at the foot of these mountainous islands, but about half way up their declivity, that they may be less exposed to the incursions of the Barbary pirates, who formerly have frequently landed there in search of plunder—Such incursions sometimes still made at present—Well-grounded fears of travellers in sailing round these islands—Useful vegetables in Felicuda and Alicuda—The corn of Alicuda excellent, though produced but in small quantity—Extraordinary industry*

of

of the inhabitants in its cultivation—Fiſhing-boats of theſe iſlands—Ridiculous and ſuperſtitious practice of the inhabitants when a huſband or wife dies——Boaſt of the people of the Lipari iſlands in general, that thoſe iſlands contain no kind of ſerpent—Phyſical reaſon of this fact—Extreme ſcarcity of inſects there, and the cauſe—Enviable tranquillity and content of the inhabitants of theſe iſlands—Salubrity of the air——Advantages experienced from that ſalubrity, by the author, during his ſtay there—Compariſon between this very pure air, and that of ſome of the low plains of Lombardy.

TO complete my obſervations relative to theſe iſlands, I ſhall now proceed to give a conciſe account of their population, the character, manners and cuſtoms of the inhabitants, their commerce, the animals ſtationary and migratory found in them, and other analogous objects; agreeably to what was propoſed in the Introduction to this work.

I. LIPARI.

THIS iſland is the largeſt and much the moſt populous of thoſe called the Eolian iſles, the number of its inhabitants amounting to between nine and ten thouſand; a conſiderable part of whom reſide in the city of the ſame name, which is very ancient, as it appears from hiſtorical records that it exiſted before the war of Troy *.

If the iſland of Lipari be divided into four parts, about two and a half will be found to be cultivated, and the remainder overgrown with wood and barren. Theſe barren tracts, however, continually diminiſh, and are converted into fruitful fields, from a kind of neceſſity ariſing from the continually increaſing population of the iſland.

Lipari produces cotton, pulſe, and olives, though in but ſmall quantities. The corn produced there, and which is of an excellent quality, amounts annually to fifteen hun-

* See Chap. XVI.

dred

dred Sicilian *ſalme* *, or two thouſand at moſt, and is ſcarcely ſufficient to ſupply the city.

Among the uſeful productions of this iſland the principal are grapes; of which there are ſeveral kinds. The firſt furniſhes the common wine which is drunk in the iſland, and of which there is ſo great an abundance that they export annually two, and even three, thouſand barrels *(barilli)* of it without the leaſt inconvenience. They preſs the grapes on the ſpot where the vines grow, and carry the muſt, in leather bottles, to their reſpective houſes on beaſts of burthen.

The paſſola and paſſolina, as they are here called, are two other kinds of grapes that are dried. The laſt is that ſort which is uſually called the Corinthian grape. Of this they commonly ſell ten thouſand barrels annually; and of the other about twelve thouſand.

* A *ſalma* contains 16 *tumuli*, the *tumulo* from 20 to 22 *rotoli*, and the *rotolo* 2½ pounds.

Stolberg's Travels, Vol. II. p. 506.

From

From a fourth kind of grape is made the famous malmſey of Lipari, which name alone is ſufficient for its eulogium. It is a wine of a clear amber colour, at once generous and ſweet, which fills and warms the mouth with an agreeable fragrance, and a return of ſweetneſs ſome time after it is taſted. But, as Nature uſually beſtows on man her moſt precious gifts with a ſparing hand, this grape is here ſcarcer than any other; and does not furniſh at moſt more than two thouſand barrels annually, which the Lipareſe ſell for foreign markets, as they do alſo the paſſola and paſſolina. During my ſtay in the iſland, I could ſcarcely procure a ſufficient quantity to revive my ſpirits after my fatigues, and carry with me a ſpecimen of this rare and delicious liquor to Pavia.

I was deſirous to learn the method employed by the natives in making malmſey. It is as follows: They do not gather the grape until it is perfectly ripe, which is known by its beautiful yellow colour and the

the ſweet taſte it acquires. When the grapes are gathered, the rotten and ſpoiled berries being firſt picked out, they are expoſed to the ſun on mats made of reeds, for eight or ten days, or ſometimes longer, till they are dried. They then place them on a clean ſtone floor, ſurrounded with a kind of low wall, about two feet high, where they cruſh them, firſt with a ſtone faſtened to the end of a ſmall ſtaff or handle, and afterwards with their naked feet, till all the juice is expreſſed; which is then let run off through an aperture to another ſimilar floor, the ſides of which are higher; and here the muſt is all collected. It is afterwards drawn off into veſſels in which it is left to ferment, till it is perfectly depurated and become fit to drink, which it is by the following January.

The vintage is in the month of September, at which time the Lipareſe, leaving the city, reſort in companies to ſome cottages near the vineyards, where they remain during the gathering of the grapes, reſign-

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ing themſelves to mirth and innocent pleaſures; and the voyager, who chances to approach the iſland at that ſeaſon, finds his ſurpriſe not a little excited by the numerous lights which are exhibited during the night, and illuminate and embelliſh theſe ruſtic habitations.

Another plant, if it does not form a branch of foreign commerce, is yet of ſome domeſtic utility to the Lipareſe: I mean the Opuntia, commonly called the Indian fig, *(Cactus Opuntia Lin.)* This ſhrub, with us, will not live through the winter, except it is preſerved in hot-houſes; and, being in a climate not congenial to its nature, grows to no great height, and produces but few fruits, and thoſe ſmall and of no worth. At Lipari, on the contrary, and in the other Eolian iſlands, it thrives ſo well that it uſually grows to the height of ten, twelve, and ſometimes fifteen feet, with a ſtem a foot or more in diameter. The fruits, which are nearly as large as a turkey's egg, are ſweet, and extremely agreeable to the palate,

palate, and of very eaſy digeſtion. When unripe, their ſkin or rind is green; but when ripe, of a reddiſh yellow. This plant will take root and grow, in a ſurpriſing manner, in almoſt any ſituation which has a favourable aſpect, and the moſt favourable is the ſouthern. It thrives alike in the pooreſt and the richeſt ſoils, the fiſſures of lavas, among the ruins of ancient buildings, on fragments of dried mortar, and in the crevices of walls. It is well known that the fruits grow at the edges of the leaves; the number on each leaf is not conſtant, but they are frequently numerous, as I have counted two-and-twenty on a ſingle leaf. They begin to ripen about the beginning of Auguſt, and continue to November. In ſome ſituations, indeed, where they enjoy the benign influence of the ſun, they remain through the whole winter; and even where they have not that advantage, they may be preſerved ripe and in good condition during the winter, by being gathered green in autumn, and left attached to the whole or a part of the leaf, the juice of the leaf, which

is always thick and pulpy, affording a nutriment to the fruit.

The inhabitants of Lipari eat theſe fruits during ſeveral months of the year; for, as there is great abundance of them, they are ſold at a very low price. Beſides thoſe which Nature produces here ſpontaneouſly, the Lipareſe induſtriouſly cultivate great numbers of theſe Indian figs, and the method of multiplying them is very eaſy. It is well known that this plant is propagated by means of the leaves, which are of an oblong ſhape, narrower at one extremity than at the other, and reſembling a peel or ſhovel, by which name they are called by the Sicilians. Every leaf is thick and pulpy, and each ſide of it ſcattered over with ſmall buttons or knobs, from which ariſe a great number of little prickles, with a large one in the centre, of the length of an inch. If theſe buttons only touch the earth, they take root, let the ground be what it may. The leaf which has taken root puts forth other leaves that again produce others; and, from being

being flat, as it was at firſt, becomes, in time, round, and forms a trunk which lengthens and thickens in proportion as the other leaves grow and multiply. For the ſtem or trunk of the Indian fig, which, as I have already ſaid, is ſometimes more than a foot in diameter, is only a ſeries of leaves in an upright poſition, and adhering to each other.

Such are the different vegetable productions of the iſland of Lipari, which, however, with reſpect to commerce, may be reduced to one only, I mean the grape. Corn, as we have ſeen, from its ſcarcity, ſcarcely deſerves to be mentioned; but this might be grown in far greater quantity were the ſyſtem of agriculture prevalent at preſent in this iſland changed. It is here the general practice to raiſe the vines two or three feet above the ground, and with poles and reeds to form a kind of ſquares by which they are ſupported. The conſequence is, that the vines with their branches and leaves form a kind of covering, impenetrable to

the rays of the ſun, which renders the ſoil below entirely barren. Several of the natives of Lipari have had the good ſenſe to perceive the inconveniences of this practice, and, diſregarding the prejudices of their countrymen, have changed theſe pieces of barren ground into fruitful corn-fields, without the leaſt detriment to the fruit of the vine. The Abbate Gaetano Trovatini, whom I have elſewhere mentioned with deſerved commendation, is among the number of the few who have made this liberal experiment. I ſaw a field of his which, though not very extenſive, nor of a better ſoil than others, produced both a plentiful harveſt and an abundant vintage. Inſtead of planting the vines in the narrow ſquares there called *pergole*, he has ranged them in parallel eſpaliers with wide interſtices of ground between them, in which he has ſown corn in ſtraight furrows, after the method of Du Hamel. Thus the air and the ſun exert their influences freely between the eſpaliers, and not a foot of ground is loſt to cultivation. The grain yields a luxuriant

crop,

crop, and the vines are, at the ſame time, not leſs fruitful than thoſe of the neighbouring grounds, where the old method is adhered to. It is true that Trovatini, like Caius Furius Creſinus in ancient times, is ſurveyed by many with an eye of ill-natured envy, when they compare the wretched appearance of their grounds with the copious produce of his. But, even while I was there, ſeveral of his neighbours had begun to imitate his example. It is much to be regretted that Don Giuſeppe Cippola of Palermo, the late biſhop of Lipari and the adjacent iſlands, did not live ſome years longer. That worthy prelate ſeemed to have been born for the improvement of the ſoil of thoſe countries, which before were wild and little productive. The number of olive-trees which he cauſed to be planted is incredible. I found above three thouſand in Panaria alone. He alſo introduced mulberry trees here, which have thriven extremely well. I ſaw one in a court-yard, planted eight years ago, which, for ſize and ſtrength, did not in the leaſt yield to ours

of the ſame age, though the latter have the advantage of a more ſuitable ſoil. He has likewiſe enriched the iſland with another ſpecies of the Indian fig, brought from Palermo, the fruit of which is red and extremely delicious. I ſincerely wiſh his ſucceſſor, who is unknown to me, may follow his excellent example.

Since I have again mentioned the Indian fig, I cannot avoid noticing an idea which has occurred to me, and which, ſhould it ever be carried into effect, muſt be productive of great advantage both to Sicily and the Eolian iſles. The cochineal inſect *(Coccus cacti Linn.)* is bred and collected in Mexico, and other Spaniſh provinces of South America, and the commerce carried on in it is eſtimated at many millions of dollars annually. Might not the advantages derived from this precious drug be ſhared with Mexico by the Lipari iſlands and Sicily, which may be conſidered as the moſt ſouthern part of Italy, from which it has been ſeparated by the irruption of the ſea

that

that produced the ſtrait of Meſſina? To effect this, two things, indeed, are neceſſary; the plant on which the inſect lives and propagates, and the inſect itſelf. The plant is that uſually called the Indian fig; and which is found in ſuch abundance in the Eolian iſles and Sicily, where I have ſeen the foot of Etna covered with it. Travellers relate that the opuntias of Mexico, where they are cultivated with the greateſt care, grow to the height of eight feet, and that the leaves of ſome of them are nearly a foot in length. We have ſaid that thoſe of Lipari, and the ſame is true of the reſt of the Eolian iſles and of Sicily, riſe to a greater height, and have leaves more than a foot long. If, therefore, theſe plants thrive as well in Sicily and the Eolian iſles, as in America, and, perhaps, better than they do there, why ſhould not the cochineal inſects, which feed on them, thrive equally in thoſe countries? Will not the ſilkworm, though originally from India, live and multiply in every country where it can be ſupplied with the

leaves of the mulberry tree? The only difficulty, in my opinion, would be the conveyance of this useful insect to so great distance, principally because it could not be removed in the egg, since it is viviparous, and not oviparous. It should be observed, however, that, as the Americans perpetuate the cochineal by means of the leaves of the opuntia, it, no doubt, would continue to live on the leaves of that plant; which might be brought, growing in large vessels filled with earth, from Mexico to Sicily. The important advantages to be derived from the success of the experiment, at least, would sufficiently justify the labour and expence of the attempt. I am not ignorant of the jealousy and reserve with which the possessors of this insect, which is so valuable to them, guard it from foreigners to prevent their stealing it. Such a theft has, however, been practised on them to the advantage of some of the French provinces. I know, likewise, that the hint I have here given, should it ever be carried into effect, would not

not be agreeable to the political views of Spain; but an Italian and a philoſopher may ſurely be permitted to propoſe it.

I ſhall now diſmiſs the vegetables, and proceed to ſay a word of the fiſhery of Lipari, than which nothing can be more wretched. Not that the ſea does not contain fiſh; but becauſe there are but few there who follow fiſhing as an occupation, and even of theſe the greater number are not provided with the neceſſary implements. They only uſe the line and hook, and the *ſciabica*, a kind of net, which they throw to a conſiderable diſtance into the ſea, and then drag on ſhore. This mode of fiſhing is only uſed in the harbour, and not very frequently, at leaſt in the ſummer, though I have been told that in winter it is more common, as they are then without other employment. I have often been preſent at their throwing the net, leſs from curioſity than to procure fiſh for my ſmall table: but thoſe days proved but unpropitious to the fiſhermen, and not leſs unlucky to myſelf; ſince after three or four throws

throws they either caught no fiſh, or thoſe ſo few and ſmall, that, had I nothing elſe to eat, I might have died with hunger.

In June and July they likewiſe fiſh for coral, both round the ſhores of Lipari, and at Vulcano. When I was there, I procured a rare ſpecimen, conſiſting of a branch of coral which had grown on a volcanic enamel under the Caſtle of Lipari. Fifteen barks, I was told, are uſually engaged in the coral fiſhery; but, either becauſe they are ignorant of the proper methods of detaching this valuable animal-plant from the rocks and caverns of the ſea, or becauſe they are not ſufficiently expert in the uſe of them, this fiſhery is very unproductive. In the two months above mentioned, every bark carrying eight men fiſhed up ten or fifteen *rotoli* of coral; and the rotolo contains two pounds and a half, and the pound twelve ounces.

Formerly coral was likewiſe fiſhed at the *Secca di Santa Caterina*, a place diſtant ten miles from the harbour of Lipari; but ſome

barks having been wrecked there, the biſhop of that time, Father de Franciſci, a Dominican, fulminated his excommunication againſt any bark which in future ſhould have the temerity to attempt to fiſh in that place.

In my various maritime excurſions round the Eolian iſles, I never met with any of thoſe ſmaller cetaceous fiſh which are frequently found in other parts of the Mediterranean. But one day when the ſea was calm, while I was ſailing between Panaria and Vulcano, a large cetaceous fiſh of the genus of the Phyſeter, and which from a long fin on the back I judged to be the *Turſio* of Linnæus, ſuddenly roſe to the top of the water. It approached within about ſeventy feet of my boat, and I had ſufficient opportunity to obſerve it with ſome attention. It is well known to mariners as well as naturaliſts, that dolphins, phyſeters, and whales, properly ſo called, have need of reſpiration from time to time, and therefore frequently riſe to the ſurface of the water with the upper part of their bodies, and throw up, from one or more apertures they have

have in the head, one or two ejections of water accompanied with the air they have taken in, and inhale freſh air. The cetaceous fiſh of which I now ſpeak did the ſame; and when he came to the ſurface of the water, and drew along the half of his body above it, he was ſo near that I could eſtimate his dimenſions with the eye. He was at leaſt twenty-eight feet long, and the breadth of his body, where largeſt, not leſs than eight feet. The caudal fin was eight feet in length, and the dorſal two. At every expiration, a hiſſing ſound was heard of air and water, which he ejected to the height of eight or nine feet. A little before he made this ejection, he raiſed nearly the half of his huge body above the water, but after five or ſix minutes again ſunk and diſappeared. I wiſhed to obſerve the interval of time between one ejection and another, as the animal continued this alternation for a full quarter of an hour. I perceived they were repeated after every ſixteen or ſeventeen ſeconds, and I flattered myſelf that I had aſcertained with ſufficient accuracy the ſpace of time that one of this ſpecies of fiſh can

remain

remain under water without being obliged to riſe to the ſurface and inhale air; but I ſoon found this calculation erroneous. After my curioſity had been gratified with this ſcene about a quarter of an hour, the animal raiſed his tail, vertically, about three feet above the water, and, plunging directly down, diſappeared; nor could I again diſcover him, though both I and the four mariners who were with me watched with the utmoſt attention during a quarter of an hour: and certainly had he, in that time, raiſed himſelf to take in air, we muſt have ſeen him, from his great bulk and the calmneſs of the ſea. I then perceived that this animal, though in his organization in a great meaſure reſembling the claſs of mammalia, and therefore, like them, under the neceſſity of reſpiring, could yet remain a much longer time under water than they can.

But if aquatic animals are of little advantage to the inhabitants of Lipari, their land animals are nearly of as little. Both large and

and ſmall cattle are there extremely ſcarce; and the few oxen and cows which are ſlaughtered there, are brought from Sicily, and are very lean. This is entirely to be aſcribed to the poverty of the paſturage. The Lipareſe cultivate themſelves the ſmall portions of land they poſſeſs.

With reſpect to wild quadrupeds, the country produces only rabbits, which make their burrows in the mountainous parts, where the volcanic matters, principally of the tufaceous kind, permit them to dig with their feet. They are hunted with the ferret (*Muſtela Furo Linn.*), and the chace is very amuſing. Though this animal be originally from Africa, it will live and propagate in the ſouthern countries of Italy. It is about the ſize of the common cat, and in its make ſomething between the weaſel and the pole-cat. I have ſeen them extremely tame at Lipari, where they breed as faſt in the houſes as when wild. The ſportſman who goes to catch the rabbits, takes with him the ferret, in a cage, and a dog. The latter,

latter, when he ſees the rabbit, follows him to the hole in which he takes refuge; or, if he is under ground, diſcovers him by the ſcent, and ſtops at the mouth of the burrow. The ſportſman then puts the *capeſtro*, a kind of muzzle made of packthread, on the ferret, that he may not bite the rabbit; as otherwiſe he would kill it in the hole, and, after having ſucked the blood, leave it there. Being unable to ſeize it, he only ſcratches it with his claws, and terrifies it till it endeavours to make its eſcape out of the burrow, and is taken in a net placed for the purpoſe. The ferret follows it out, and is again put into the cage.

Theſe rabbits are ſmaller than the tame ones, and, like others that are wild, are of a grey colour. Not that they are originally ſuch; ſince it is within memory that they were firſt brought there by one of the natives, where they have, as is uſual with them, multiplied prodigiouſly. But Nature, put under reſtraint by man, never fails to reſtore to animals which regain their liberty,

the

the ſize and exterior habit of body which they had in their original ſtate.

The birds ſtationary here are but few. They are the partridge *(Tetrao Perdix Lin.)*, the greenfinch *(Loxia Chloris Lin.)*; the ſparrow *(Fringilla domeſtica)*, the goldfinch *(Fringilla carduelis)*, the horn owl *(Strix Scops)*, and the raven *(Corvus Corax)*. The latter is uſually found about the cultivated fields near the ſtoves, and on the ſteepeſt rocks, though ſometimes in places ſufficiently acceſſible for the young ravens to be taken.

Of thoſe kinds of water-fowl which migrate from one ſea to another, according as they find food in greater or leſs plenty, and paſs indifferently from the ſalt water of the ſea to the freſh of rivers, lakes, and ponds, ſuch as the different kinds of ſea-gulls *(Lari Linn.)* and the cormorant *(Pelicanus Carbo)* I did not ſee one here. Indeed it is very rarely that any kind of water-fowl is ſeen in the Eolian iſles.

It

It is not the ſame with the birds of paſſage. In April the turtle-dove *(Columba Turtur)* and the quail *(Tetrao Coturnix)* arrive here, and ſtay a few days. They come in the ſame manner in September. Several kinds of ſwallows are common here *(Hirundo ruſtica, urbica, apus, melba.)* The two latter make their neſts in the fiſſures of the rocks, and in the higheſt walls of the city of Lipari. When I left that city, which was on the 15th of October, ſome ſwallows of the firſt and laſt ſpecies were flying over it. I ſhall likewiſe obſerve, that on the night of the 13th of the ſame month there was a dreadful tempeſt with lightning, rain and hail; and the next day, early in the morning, a ſtrong ſouth-weſt wind blowing, I ſaw in the air, over the Caſtle of Lipari, at leaſt a hundred common houſe-ſwallows, though they ſoon after diſappeared. Reaumur's thermometer, that morning, ſtood at $15\frac{5}{6}$ degrees above zero ($67\frac{1}{2}$ of Fahrenheit).

In ſome converſations relative to ſwal-

lows, which I had with Doctor Trovatini and ſeveral other perſons at Lipari, they related to me a fact which I had before heard at Stromboli, and ſhall again mention when I come to treat of that iſland. It is that in winter, and when a ſciroccal or warm ſoutherly breeze blows, ſwallows of one or other of the four ſpecies above mentioned are frequently ſeen to ſkim the ground in the ſtreets of the city, and are then eaſily knocked down with long ſticks by children, as they are extremely wet. The two latter kinds are even taken with hooks and lines faſtened to the extremity of a long reed. A ſmall feather is faſtened over the hook, and the boy who holds the reed, conceals himſelf behind the corner of a ſtreet, and waves the feather in the air. The ſwallow, accuſtomed to catch inſects as it flies, takes the feather and is caught by the hook.

From theſe obſervations we cannot but conclude, that theſe ſwallows do not paſs into Africa at the approach of winter, as many have believed, but that they more probably

probably remain in the iſland, and iſſue from their retreats in the warm days of winter in queſt of food.

I ſaw likewiſe at Lipari, while making the circuit of the iſland by ſea, a fifth ſpecies of ſwallow; the ſwallow of the bank *(Hirundo riparia Linn.)*. This bird is ſo denominated from building its neſt in the banks of rivers, and ſometimes the ſhores of the ſea. I obſerved ſeveral of theſe ſwallows flying about the rocks of tufa, which deſcend almoſt perpendicularly into the ſea; and having ſtopped there ſome time with my boat, I ſaw more than one of them go into, and come out of the holes they had made in the tufa. I was told by the people of Lipari, that this kind of ſwallow appears in March, and diſappears in October.

In the Introduction to this work I have mentioned that it was my intention to add to the obſervations I ſhould make on the ſwallows of Lipari and Sicily, others which I had made on the ſame ſpecies of bird in

Lombardy; which addition would not have been so long, but it might have been here conveniently subjoined. But having afterwards more fully considered the subject, and made new and various experiments to elucidate the great controversy, whether swallows remain torpid during the cold weather, of which I have slightly treated in my other works (see my Annotations on the Contemplation of Nature; and Tracts on Animal and Vegetable Physics*); and having afterwards extended those experiments to other animals which are in like manner torpid in winter, and especially those whose blood is cold, as the common hedge-hog *(Erinaceus Europæus Linn.)*, the marmot *(Mus Marmota)*, the dormouse *(Mus avellanarius)*, the bat *(Vespertilio)*, I found my matter so increase on my hands, that I determined to publish my observations on this subject separately, after having finished the work in which I am at present occupied.

* Annotazioni alla Contemplazione della Natura.—Opuscoli di Fisica Animale e Vegitabile.

We

We will now proceed to notice ſome other particulars relative to Lipari and its inhabitants. Foreign commerce has begun to be introduced into the iſland by the mariners; moſt of whom traffic in what they call gallantry-wares. They every year buy, at the fair of Sinigaglio, linen, muſlins, veils, and other commodities of that kind, to the value of from thirteen to fourteen thouſand Sicilian *oncie**, and ſell them at Meſſina, Catania, Palermo, and other parts of Sicily. This trade is very advantageous to the country, and many have acquired conſiderable wealth by it. It has, however, conſiderably diminiſhed the fiſhery, and raiſed the price of fiſh.

Strabo, Diodorus, and Dioſcorides, write that the ſulphate of alumine (alum) was

* Count Stolberg, in his Travels, lately publiſhed, ſays the *oncia* of Sicily is worth three rix-dollars and nine good groſchen; or about eleven ſhillings and nine-pence. The German tranſlator of this work eſtimates the *oncia*, I know not on what authority, at ſix dollars.—T.

procured in great abundance at Lipari. The truth, however, is, that none whatever of that ſalt is now extracted in the iſland. I have paſſed over almoſt every foot of ground in it, and only found ſome traces or efflorescences of it, as I have mentioned in the proper places, which, with reſpect to profit, would not pay the labour of collecting. We muſt therefore conclude that the vein of this mineral has either been exhauſted or loſt; or that the Lipareſe procured it, not from their own iſland, but the neighbouring one of Vulcano, which is ſtill rich in this ſulphate. The latter is, perhaps, the moſt probable explanation of the authorities above alleged.

The political adminiſtration of Lipari is compoſed of a criminal judge, a fiſcal, a governor who has the chief authority both in military and civil affairs, and who is commonly an old invalid; and a civil judge.

The biſhop, ſeventeen canons of the firſt order, and fourteen of the ſecond; and from

a hundred and twenty to a hundred and thirty prieſts, form the eccleſiaſtical eſtabliſhment.

The natives of this iſland are not wanting in natural abilities, but in the cultivation of them. The Lipareſe are, in general, of a prompt and lively wit, ready to learn, of acute penetration, and extremely deſirous of obtaining knowledge. Hence, when any learned ſtranger viſits their iſland, there is no end to their queſtions and enquiries. They willingly become his guides to their ſtoves and baths; and there is not one among them who is ignorant that his country was once produced by fire. The ſeat of the court of King Æolus is conteſted in the Eolian iſles, as the birth-place of Homer is in Greece. He is claimed by each of the iſlands; but the people of Lipari are fully perſuaded that the royal reſidence of this petty ſovereign was in their iſland; and thoſe among them who have ſome little tincture of literature, can cite the authority of Ho-

mer and other writers in proof of their aſſertion.

A beggar is ſcarcely ever to be found in Lipari; for even the pooreſt perſons have ſome ſmall piece of ground which they cultivate, and by the produce of which they live.

The natives are uſually robuſt, ſtrong, rather of a large ſize, and comely. When young they have fine complexions; but fatigue will diminiſh every kind of beauty, even that of the fair ſex. This change is greatly accelerated by the heat of the ſun; the effects of which are conſpicuous in their tanned ſkins and ſwarthy countenances.

If it was a diſgrace in Greece to be unable to ſwim, it is not leſs ſhameful in Lipari and the other Eolian iſles, to be ignorant either of that art, or that of managing the oar, or ſteering and handing the ſails of a veſſel.

The

The prieſts are very expert in every exerciſe of this kind. The greater part of them have, like the ſailors, their arms or hands marked with black indelible ſtains repreſenting either the crucifix or ſome ſaint. I knew, at Lipari, a man of conſiderable property, and who was honoured with the title of Baron, who was marked in this manner, having formerly been a mariner.

The city of Lipari is not of an extenſive circuit, and conſiſts rather of narrow alleys than ſtreets. The caſtle is ſurrounded with a wall on which are mounted a few cannon, and is defended by a ſmall garriſon. The houſes are very indifferent buildings, but three edifices are diſtinguiſhable from the reſt. Theſe are the palace of the biſhop, the houſe of the governor, and the cathedral church. The latter contains very valuable ſacred utenſils, and a great quantity of plate and ſilver images, among which is the ſtatue of St. Bartholomew, their patron ſaint. Theſe have been collected entirely at the expence of the people, and the value of this treaſure

is ſaid by thoſe who underſtand it to amount to ninety thouſand Neapolitan *ſcudi* *.

II. STROMBOLI.

THOUGH both Stromboli and Lipari lie nearly under the ſame degree of latitude, or 38° N. the former is much hotter, in ſummer than the latter; eſpecially near the ſea, on account of the ſtrong reflection of the rays of the ſun from the large tracts of ſand. It does not appear probable, however, that this heat is to be attributed to its volcano, ſince, excepting a few places near its mouth, if we dig into the earth, we find the ground leſs warm at ſome depth than on the ſurface.

The winter here is always mild; it never freezes; and ſnow, which is ſeldom ſeen, if it fall one day, melts the next. Its greateſt depth is about two inches; and it is related as a prodigy that, ſome years ſince, ſnow

* The Neapolitan *ſcudo* is worth about 4s. 3d. T.

fell

fell on the firſt of November, to the depth of a palm (or nearly a foot). On the ſummit of the mountain, indeed, ſnow falls more frequently, and ſometimes will remain for a fortnight; which proves the height of the mountain to be very conſiderable.

The ſea round this iſland is frequently agitated by ſtorms, and the fact I am proceeding to mention will ſhow to how great a height its raging billows beat.

About a mile from the land, on the north-eaſt ſide of the iſland, riſes a ſpacious naked rock, called the Rock of Stromboli. It conſiſts of one entire piece, has rugged points at the top; and its baſe, where it is waſhed by the water, is about a quarter of a mile in circuit. Its greateſt height is three hundred feet. This rock is a huge maſs of lava, which, probably, once was joined to the iſland, and has ſince been ſeparated from it by the violence of the ſea. The natives of Stromboli have obſerved that, in very great ſtorms, the billows riſe to one half the height of

of this rock; and ſome of them have aſſured me that they have twice in their time ſeen the waves riſe above the top of the rock. As, therefore, in general, the agitations of the ſea are only a conſequence of thoſe of the air, we may form ſome conception of the fury of the winds, which are here more violent than in any of the other Lipari iſlands. Theſe hurricanes, which frequently ariſe on a ſudden, lay waſte the plantations, and wreck the barks expoſed to their fury. To avoid as much as poſſible the effects of their violence, the houſes here are built very low.

The ſhore of Stromboli has neither port nor harbour, and veſſels can only ſeek ſome little refuge, in caſe of heavy ſtorms, on the back of the iſland. Large ſhips, except compelled by neceſſity, never anchor there, from fear of running on ſand-banks. The veſſels employed by the natives for their own occupations are feluccas, which, being extremely light, are eaſily drawn up on land, and as eaſily launched again into the ſea.

The

The fiſh here are very plentiful and large, eſpecially the ſea-eels and murenas; and, during my ſhort ſtay in this iſland, I ſaw a greater quantity taken than during the whole time of my continuance in all the other Eolian iſles. They are, likewiſe, of an excellent taſte. This abundance I am inclined to attribute to the volcano, which has continued inceſſantly burning from time immemorial; and which, extending to an immenſe depth, muſt neceſſarily communicate a part of its heat to the ſubmarine baſe of the mountain, and to the waters that ſurround it, in the gentle warmth of which the fiſh find a more agreeable place of reſort, and perhaps propagate in greater numbers than elſewhere. The fiſhery, however, produces here no branch of commerce, and only ſerves to ſupply the iſland, principally the foreigners who viſit it; as the natives uſually live on ſalt meat, and ſtrangers can rarely find any food ſo agreeable to their palate as fiſh.

The vegetables that grow in Lipari are found

found here likewiſe, and nearly in the ſame proportion. Malmſey is the greateſt article of traffic of the people of Stromboli; they convey it in barrels to Lipari, where they find a ready ſale for it. The vines producing the *paſſola* and *paſſolina* grape, and that from which the malmſey is made, grow on the ſea-ſhore; and thoſe for the common wine, on the ſides of the mountain. Some of them are faſtened to trees; but they are all planted in vineyards; and, where theſe are ſituated high, they are ſurrounded with thick reeds, which at once ſupport and defend them from the wind. The vines form a chain to the north-eaſt, and are all planted in volcanic ſand.

The habitations of the iſlanders are built in the ſame part, and under the ſame aſpect. They are an irregular aſſemblage of cottages and fiſhermen's huts. The population of the iſland amounts to about a thouſand perſons, and has been for ſome time increaſing; in conſequence of which exertions have been made to enlarge the cultivable ground by

by clearing away the woods. They have no fear of their volcano. Neither they nor their fathers having ever ſeen torrents of lava burſt forth from its furnace and ſpread deſolation around, as has happened from time to time at Etna and Veſuvius; they ſurvey its more conſtant fires with an eye of indifference and ſecurity.

Mr. Brydone, in his Tour through Sicily and Malta, tells us that, notwithſtanding his great deſire to viſit this volcano, the only one of its kind, he did not venture to land at Stromboli for fear he ſhould be ill uſed by the inhabitants, whom he believed to be little other than ſavages. On the contrary, M. Dolomieu was very civilly received by them. The treatment I received from them, and the converſations I had with them, likewiſe convince me that the Engliſh traveller muſt have been very wrongly informed. The character of theſe iſlanders is nearly the ſame with that of the inhabitants of other villages at a diſtance from, and having no communication with, populous cities; I mean

mean they are ſimple, honeſt, and, having but few ideas, are contented with the little they poſſeſs. Their longeſt journey is uſually to the city, which, though it is ſmall, appears to them wonderfully magnificent; and, when they firſt enter it, they are affected like Dante's ruſtic.

" Non altrimenti ſtupido ſi turba
" Lo Montanaro, e rimirando ammira,
" Quando rozzo, e ſelvatico s' inurba."

" Thus the rude clown who, for the firſt time, views
" Of ſome throng'd capital the wealth and pride,
" Gazes with open mouth, in wonder wild."

A little above the baſe of the mountain, on the eaſt ſide, is a ſmall ſpring, the ſcanty ſupply of freſh water from which would be inadequate to the wants of the inhabitants, were it not for a more copious and inexhauſtible ſtream at a little diſtance from it, which furniſhes them with water to diſpel their thirſt, and without which they could not exiſt, when, in ſummer-time, the rain-water they have preſerved in their ciſterns is entirely exhauſted. M. Dolomieu, who viſited

viſited this fountain, ſuppoſes it to owe its origin to evaporation cauſed in the mountain by volcanic heat and ſucceeded by condenſation at a certain height, it not appearing to him poſſible that this ſpring ſhould have its reſervoir in the higher parts of the mountain; as theſe are compoſed of ſand and porous ſtones, and, therefore, are unfit to retain water. This hypotheſis is certainly both ingenious and probable; but may not another be equally probable which ſuppoſes this ſpring to be ſupplied from the ſummit of the iſland, where the earth being ſandy and full of pores, the rains eaſily penetrate it, and, collecting in the cavities below, form a maſs of waters at all times ſufficient to ſupply the ſpring? According to this hypotheſis, the reſervoir will not be on the ſurface, but in the internal part of the mountain. The objection that the heat of the volcano would reduce ſuch a body of water to vapour will be found to be of little weight, ſince the ſpring is more than a mile diſtant from the crater; and it is very probable that the activity of the fire does not

extend ſo far; indeed it ſeems almoſt certain; for we do not perceive for a conſiderable ſpace around it, notwithſtanding the poroſity of the earth, the ſlighteſt trace or indication of thoſe fumes which are the moſt certain indication of ſubterranean fires. In fine, the origin of this ſpring, which never fails, can only be explained in the ſame manner as that of other fountains of freſh water in other iſlands.

We find here no ſtationary birds whatever. Attempts have been ſeveral times made, but in vain, to naturalize partridges here. The experiment has ſucceeded better with rabbits. Thoſe formerly brought have multiplied, and continue to multiply; living in their natural wild ſtate, in the woody part of the iſland. The muſket and the ferret are their only enemies.

The birds of paſſage are the ſame as at Lipari. When I was at Stromboli in the beginning of October, I ſaw three ſwallows (*Hirundo ruſtica Linn.*) flying over the iſland; and

and ſeveral of the inhabitants aſſured me that they frequently re-appear in winter, when a warm wind has rendered the air warmer than ordinary.

III. VULCANO.

THIS iſland is not inhabited, nor is it remembered that it ever was. It is more than probable that its numerous eruptions have occaſioned it to be thus deſerted. It is not, however, more than a century ſince it was of conſiderable utility to the people of Lipari from the quantity of ſulphur and ſulphate of alumine (alum) they procured from it; bringing away annually, if we admit the eſtimate of Pietro Campis *, to the amount of four thouſand *cantara* † of the

* Diſegno Iſtorico della Città di Lipari.

† The Neapolitan *Cantara* or quintal is of two kinds; the *groſſo*, or the great, and the *piccolo*, or the little. The great cantara contains 100 *rotoli*, and 3 rotoli make 8 pounds 4 ounces Neapolitan weight, the pound containing 12 ounces. The little cantara contains only 100 ſuch pounds. T.

former, and ſix hundred of the latter. We have already mentioned the ſulphur of this iſland, and the difficulties with which it is procured, in Chap. XIII. Sulphate of alumine ſtill abounds here; but the extraction of it is attended with the ſame difficulties as that of the former mineral. Theſe are occaſioned by the numerous ſulphureous fumes, and the heat, which exhale from the ſubterranean caverns, and which are found the ſtrongeſt in the places where that ſalt moſt abounds. I am, therefore, of opinion that, at the time theſe ſubſtances were dug here, the ſtate of the volcano muſt have been different.

The people of Lipari might, however, if I am not miſtaken, derive another more ſtable advantage of which they have hitherto been ignorant, or have neglected, from this deſerted iſland. This would be obtained from the productive plantations that might be made in the ſouthern parts of the iſland, to which, for a great length of time, the fire has never extended its injuries. This part

of

of the iſland conſiſts of a ſoftened and half-crumbled lava, ſimilar to that of Stromboli, where vines thrive ſo well; nor can I diſcover why they ſhould not ſucceed equally well in Vulcano. The ſame idea has occurred to Trovatini; and the biſhop of Lipari, whom I have before mentioned with the reſpect which is due, told me that he had thoughts of attempting the cultivation of Vulcano by ſowing corn and planting vines and fruit-trees.

The biſhop likewiſe communicated to me another idea which I did not expect. He ſaid he had conceived the deſign of building a ſeminary in that iſland, for the education of twelve youths, ſons of the peaſants, who ſhould be brought up to the ſervice of the cathedral, and of the pariſh churches of the other Eolian iſles. He very juſtly thought that theſe youths, having been born and educated in the iſlands, would be better fitted for, and more attentive to, the diſcharge of ſuch duties. Whether ſince the death of this

prelate any attempts have been made to carry his uſeful plans into execution, I cannot ſay. The little diſpoſition which thoſe who ſucceed to any office uſually ſhew to complete the projects of their predeceſſors, inclines me to think it very doubtful whether Vulcano will not ſtill remain in its former deſerted and barren ſtate.

IV. SALINE.

DIDYME, or, as it is at preſent called, le Saline (or the ſalt pits), is very different from Vulcano. This iſland in many parts has its ſkirts covered with cottages, and abounds in vines, the grapes of which yield wines not inferior to thoſe of Lipari.

At a little diſtance from the ſea, near Santa Maria, a continual ſpring of freſh water riſes. The great heat of many ſuch ſprings is uſually an unequivocal ſign, if not of the exiſtence of a volcano, at leaſt of ſubterranean effervescences. This, however, when I examined it by the thermometer, appeared to

be

be $2\frac{1}{2}$ degrees cooler than the temperature of the atmoſphere*. It formerly iſſued nearly on a level with the water of the ſea, with which it frequently mixed, and thus became almoſt uſeleſs to the inhabitants; but this inconvenience has within theſe few years been remedied, by a vertical ſection being made in the ſhore; in conſequence of which it now iſſues fifteen feet above the level of the ſea. It is very abundant, and throws up five ſtreams of water, each about an inch in diameter, which is very extraordinary in a volcanic iſland; at leaſt in any of thoſe of Lipari.

This plentiful ſpring, there can be no doubt, is ſupplied by rain-water, as, in the preſent time, the opinion that fountains and rivers are immediately derived from the ſea,

* I ſhall here obſerve that, excepting ſome places in Stromboli, Vulcano, Lipari, and a ſpring in Felicuda, I never could perceive, though I uſed the thermometer, that the Eolian iſles, other circumſtances being the ſame, are warmer than Meſſina, the coaſts of Calabria, and other neighbouring countries which are not volcanic.

is entirely exploded. The rains, however, by which it is nouriſhed are not to be ſought in remote countries; they can only be thoſe which fall on the iſland. It muſt at the ſame time be confeſſed, as I was aſſured by the natives, that there has ſometimes been no rain there for nine months, and yet this ſpring, in all that time, did not appear to ſuffer the ſmalleſt diminution. In what manner then ſhall we account for this, if we aſcribe its origin to rain-water? I can ſee no abſurdity in the ſuppoſition, on the contrary, it appears to me extremely probable, that, in the internal parts of an iſland which, like this, is the work of fire, there may be immenſe caverns that may be filled with water by the rains, and that in ſome of theſe which are placed above the ſpring, the water may always continue at nearly the ſame height, and a long drought conſequently produce no alteration in the ſpring. By a ſimilar hypotheſis, which does not appear to me at all forced or unnatural, we have explained above the origin of the ſpring which continually flows in Stromboli.

I have

I have already mentioned that this iſland received the name of Saline (ſalt-pits) from the muriate of ſoda (ſea-ſalt) which is obtained in it. A brief account of this product, and the place where it is procured, may not be unacceptable to my readers. Cloſe to the ſhore, on the ſouth-eaſt ſide of the iſland, there is a lake of about a mile in circuit, ſeparated from the ſea only by a bank of lava, not formed by art, but by the ſea itſelf, which has raiſed it by the beating of its waves. It appears indubitable, that this lake was once a ſmall bay or creek of the ſea, which has been ſhut out by the accumulation of the lava, though its waters are ſtill admitted by ſecret channels; ſince, notwithſtanding the continual evaporation, the lake remains full. In conſequence of this continual evaporation, however, the water in it becomes ſalter than that of the ſea, and in conſequence forms a cruſt of muriate of ſoda (ſea-ſalt) on its banks. The lake has every appearance of being very ancient, but had been long neglected; until in the year 1750 an attempt was made to render

render it more advantageous, under the direction of a native of Trapani, who was acquainted with the nature of ſalt-works. He firſt drained the lake, and then dividing it into thirty ſquare pits, each ſeparated by high banks, let in the ſea-water to a certain height, which gradually evaporating by the heat of the ſun, which in ſummer is there very great, left on the ſides of the banks and at the bottom a ſtratum of ſalt. This method has been continued ſince, and the ſalt collected twice or thrice every year, according as the heat of the ſeaſon more or leſs favours the evaporation. The quantity procured is ſufficient to ſupply all the Lipari iſlands.

The inhabitants from whom I received this account related to me at the ſame time a fact that excited my ſurpriſe. The ſea in a violent ſtorm making its way into the lake, carried with it a number of fiſh of the *cephalus* or chub ſpecies, which continued to live in the lake as in their native element. They multiplied very faſt, notwithſtanding

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the water by a new evaporation was rendered extremely ſalt; and when they were afterwards taken out, they were found to be very fat and well-flavoured. This the more ſurpriſed me, becauſe ſome years before, in another part of the Mediterranean, that is where the river Magra falls into the ſea, near Carrara, I had obſerved this ſpecies of fiſh delight in water almoſt freſh; leaving the open ſea for the mouth of the river, and appearing to ſeek thoſe places in which the ſea-water, mixed with that of the river, had leſs ſaltneſs; to which places the fiſhermen reſorted to catch them. Other ſpecies of ſea-fiſh without number are of a very different nature, not being able to live in water which is ſalter than that of the ſea. Thus near Chiozza, in the Venetian ſtate, I have found ſome which preſently died when put in water ſaturated with muriate of ſoda (ſea-ſalt), nearly the ſame with that of the lake above mentioned, and prepared for the ſame uſe. Such a difference of temperament in animals formed to inhabit the ſea muſt doubtleſs be the reſult of a difference of organization,

ganization, though we are ignorant in what it conſiſts, leſs perhaps from the difficulty of diſcovering it, than from our not having directed our enquiries towards this part of the animal œconomy.

V. VI. FELICUDA AND ALICUDA.

THESE two iſlands are the laſt of thoſe of Lipari towards the weſt. In Felicuda the houſes are ſcattered over the whole iſland, which contains about ſix hundred and fifty inhabitants; but in Alicuda, the population of which is not ſo great, they are built only at the ſouth and ſouth-eaſt end of the iſland; it being in fact impoſſible to build them any where elſe, the reſt of the iſland conſiſting only of cliffs, and crags, ſteep precipices and inacceſſible rocks. It is obſervable that theſe houſes, or rather cottages, are not erected at the ſhore, or baſe, of theſe mountainous iſlands, but about half way up on the ſide which has a very ſteep declivity, where likewiſe ſtand the houſes of the two pariſh prieſts. I at firſt was unable to conceive

why a ſituation ſo difficult to reach from the ſteepneſs of the aſcent, had been preferred for their houſes to the lower part of the iſlands, which is much leſs ſteep and nearly level with the ſea. But I was told by both the peaſants and the prieſts, that this ſituation had been choſen by their anceſtors becauſe that formerly Felicuda and Alicuda, being the moſt remote from the principal iſland, were greatly expoſed to the attacks of the Turks, eſpecially the Tuniſian corſairs, who frequently landed there in the night, ſurpriſed the iſlanders while aſleep in their houſes near the ſhore, plundered them of their goods, and carried them away into ſlavery, as they have ſometimes made ſimilar predatory deſcents, in the preſent times, on the coaſt near Genoa. The people of Alicuda and Felicuda on this account built their houſes where the danger was leſs. The Eolian iſlands are indeed ſtill liable to ſuch viſits from their African neighbours. It is true the latter do not always ſucceed in their deſign, but ſometimes pay dearly for their temerity; yet it is neceſſary for the

the iſlanders to take every precaution, on which account there is a ſentinel ſtationed on the Monte della Guardia at Lipari, who is on the watch night and day. This, however, does not deter the barbarians from frequently ſtretching over to thoſe iſlands; where they lie in wait under a rock, a cape, or a point of land, till they ſee ſome ſmall veſſels, when they dart like vultures on their prey incapable of reſiſting their force, and ſetting their ſails, if the wind be favourable, or labouring with their oars, are ſoon out of ſight of the iſlands and in the open ſea; where it little avails the unhappy wretches they have made ſlaves to lament their fate or ſue for mercy. I will confeſs that, frequently, while making the circuit of theſe iſlands, I was not without my fears that I might in this manner be carried to make obſervations of a very different kind on the neighbouring coaſts of Africa.

Beſides Indian figs and ſome olive-trees, theſe two iſlands contain many vines, from the grape of which a good wine is made, though

though it is not malmſey, nor the grape the paſſola or paſſolina.

The corn grown here is barley and wheat; of which, together with the grapes, there is produced in Alicuda to the value of about three thouſand Neapolitan crowns; and about one-third more in Felicuda. This quantity of corn is ſufficient for the ſupport of Alicuda; but the produce of Felicuda is not ſufficient for it; the Lipareſe, who are owners of a number of the ſmall farms there, carrying away a conſiderable quantity.

The induſtry and patience of the people of Alicuda is incredible: they do not loſe an inch of the ground they cultivate. There is ſcarcely a tract of cultivable land of a few perches in circuit, which is not interrupted with points of rocks, maſſes of lava, clefts, and crags: yet all theſe tracts they render productive: they turn and break them with pointed ſpades, and render every foot of them fruitful; on which account the Lipareſe ſay, jeſtingly, that the people of Ali-

cuda till their lands with the point of a knife. It is certain, at the ſame time, that in all the Eolian iſles there is no better bread than that made in Alicuda. I have taſted it, and can affirm that it is moſt excellent.

Few fiſh are taken in theſe iſlands, becauſe there are but few fiſhermen, and theſe have no nets, but only uſe the hook and line. The whole number of boats, likewiſe, either uſed for fiſhing, or to paſs from one iſland to the other, is only five or ſix in Felicuda, and three or four in Alicuda. When they no longer want to uſe them, they draw them up out of the water on the dry beach, where the ſea cannot reach them, till they again have occaſion for them. One or two of theſe boats uſually belong to the pariſh-prieſt, who not only makes uſe of them in fiſhing, but for other purpoſes; as to go to market to Lipari, or to accommodate a ſtranger, in which caſe he will not refuſe to act as pilot, or, on an emergency, as rower. Neceſſity, the mother of induſtry, impels theſe good prieſts

prieſts to endeavour to find employment, as they could ſcarcely live, however wretchedly, one half the year, on their eccleſiaſtical revenues, which amount to little more than twelve ſequins, annually, for each iſland.

At Felicuda, when the huſband or wife died, it was a cuſtom conſidered as a kind of ſacred duty for the neareſt relations to follow the body to the grave with loud and immoderate lamentations, and, as ſoon as the obſequies were finiſhed, to throw themſelves upon the corpſe, embrace it, kiſs it, ſpeak to it with a loud voice, and give commiſſions for the other world. This ridiculous practice, which is not modern, has been aboliſhed by the preſent prieſt.

In neither of theſe iſlands is there a ſingle ſpring of freſh-water. The inhabitants are therefore obliged to have recourſe to the rain-water they can preſerve in ciſterns; and, when it happens not to rain for ſeveral months, their diſtreſs is extreme.

The people of Alicuda and Felicuda, in fact, of all the Eolian iſles, boaſt that their iſlands are exempt from every kind of ſerpents; and, indeed, in all my excurſions in them, I never met with one. The reaſon of this evidently is becauſe the food neceſſary for theſe creatures is wanting: they feed principally on inſects and other ſmall animals, of which I found here very few. The ſcarcity of theſe latter is likewiſe to be accounted for on the ſame principle; as it is known that they feed on vegetables chiefly of the herbaceous kind, which, in theſe iſlands, are extremely rare.

Of other animals of the amphibious kind I only met with the gray and green lizard *(Lacerta agilis Lin.)*, and, with reſpect to inſects, only ſome graſshoppers, and the lion-ant *(Myrmeleon formicarius Lin.)* which are found in great numbers among the duſt of the pumices and lavas.

The people of theſe iſlands may likewiſe boaſt of an advantage incomparably more important;

important; I mean, that their ſovereign, in conſideration of their poverty, has exempted them from every kind of taxation, only paying tythes to the biſhop, from which, however, the people of Lipari are exempted.

It is incredible, at the ſame time, how contented theſe iſlanders are amid all their poverty. Ulyſſes, perhaps, cheriſhed not a greater love for his Ithaca, than they bear to their Eolian rocks, which, wretched as they may appear, they would not exchange for the Fortunate Iſlands. Frequently have I entered their huts, which ſeem like the neſts of birds hung to the cliffs. They are framed of pieces of lava ill joined together, equally deſtitute of ornament within and without, and ſcarcely admit a feeble uncertain light, like ſome gloomy caves. Sometimes I have been preſent at their wretched meals, ſet out in coarſe diſhes, or on the bare ground on which they ſat, and conſiſting of black barley bread, and wild fruits, and, ſometimes, by way of dainty,

ſome ſalt-fiſh, and pure water to quench their thirſt. Attending only to the firſt impreſſion of the ſcene, I thought I beheld the perfect image of wretchedneſs and miſery: but, on more mature conſideration, I diſcovered in theſe rude huts, and in the midſt of this hard fare, an enviable happineſs, which, I doubt, is not to be found in the palaces of the great, or amoug the delicious viands of royal tables. A cheerfulneſs and perfect tranquillity ſhone in the countenances of theſe poor people, and evidently poſſeſſed their hearts. Their ruinous cottages, which muſt be viewed with pity and contempt by the rich and great, to them were dear; and the food, which the luxurious would have rejected as inſipid or nauſeous, to their palates had an exquiſite flavour. But the frugal meals of theſe iſlanders are always ſeaſoned with a ſauce which never accompanies the diſhes at the tables of the great, I mean hunger and thirſt, which render every meat delicious and every beverage grateful. The labour of their hands and the ſweat of their brow

ſecure

ſecure an exquiſite reliſh for their ſcanty fare.

As to the content and tranquillity of theſe iſlanders, and the affection they bear their native country, I do not think I ſhould greatly err, were I to aſcribe it to the happy temperature of the climate, and the quality of the air, which, when pure, ſo much contributes to maintain in us the proper harmony between the ſolids and the fluids, or the ſtate of perfect health. A proof of this I experienced in myſelf. Notwithſtanding the continual and great fatigues I underwent in my excurſions among thoſe rocks, and notwithſtanding my advanced age, I felt in myſelf an energy and vigour of body, an agility and livelineſs of mind, and a certain animation of my whole frame, which I had experienced no where elſe, except on the ſummit of mount Etna. In countries infeſted with impure air and thick vapours, I have never been able to apply myſelf to my favourite ſtudies immediately after dinner; but, under this ſky, which is ſo rarely

overclouded with vapours, I could write on the ſpot, at any time, a part of thoſe obſervations I am now about to preſent to the public. How immenſe the difference between this moſt pure and almoſt celeſtial air, and the fœtid and foggy atmoſphere of ſome of the low plains of Lombardy, ſurrounded by ſtagnant and filthy waters and unhealthy rice-grounds, producing continual clouds and fogs in winter, and obſtinate fevers in ſummer; where the ſpirits are depreſſed, and rendered dull; and where, to complete the catalogue of ills and inconveniences, innumerable hoſts of frogs, in the warm ſeaſon, both by night and day, deafen the ear with their inceſſant croakings!

CHAP. XXV.

STATE IN WHICH THE AUTHOR FOUND MESSINA AFTER THE EARTHQUAKE IN 1783—ACCOUNT OF THE CALAMITOUS ACCIDENTS WHICH BEFEL THAT UNFORTUNATE CITY.

Great numbers of the people of Scilla drowned by the waves of the ſea—A long range of palaces adjoining to the harbour, almoſt all deſtroyed—Prodigious number of edifices within the city either thrown down, or on the point of falling—Wooden ſheds erected by the people of Meſſina to lodge in till the houſes could be rebuilt—Injurious effects produced by fear which had ſeized entirely on the minds of the inhabitants—Account of the different dreadful ſhocks which laid waſte the city, and the circumſtances by which they were preceded and accompanied—Other ſhocks followed, but

ſucceſſively weaker——The buildings of which the foundation was granite leaſt damaged——The mole, which was conſtructed in ground not ſufficiently ſolid, entirely carried away and buried in the ſea—Enumeration of the more conſiderable edifices which were reduced to ruins—Incalculable loſſes ſuſtained by the deſtruction of the monuments of the arts, and the property buried under the ruins, or conſumed by the fires which broke out after the earthquake in different parts of the city—Exertions of the King of the Two Sicilies to reſtore Meſſina to its former flouriſhing ſtate.

IN the forenoon of the 14th of October, I left the Eolian iſles, and ſailed from Lipari, in a felucca, for Meſſina, which is diſtant from that iſland thirty miles, but where I did not arrive till the middle of the next day; partly from having ſtopped ſome time to make obſervations on the granites of Melazzo, and from the want of wind, which obliged the mariners to have recourſe to their oars. With theſe iſlands I was to diſ-

miſs every idea of volcanos either ſtill burning or extinct, as that part of Sicily to which I was approaching exhibited not the leaſt trace of that nature. I do not mean to ſay that at different times it may not have ſuffered by their deſtructive effects, if it be true, as I believe it to be, that partial earthquakes, that is, thoſe which are felt through a not very extenſive tract of country, and at a ſmall diſtance from a volcano, originate either mediately or immediately from that volcano. In fact, what iſland has ſuffered more in this manner than Sicily, and that from nouriſhing within its boſom the Etnean conflagrations? When I travelled in thoſe parts, the dreadful effects of the earthquake of 1783 were the common ſubject of diſcourſe. On my entering, in the felucca, the Strait of Meſſina, ſome of the people who were with me pointed out to me the ſhore of Scilla where a great number of people were drowned at that calamitous time. A dreadful ſhock of an earthquake took place, about noon, on the 5th of February of the above year, which terrifying

fying the people of Scilla, they fled in crowds to the ſhore, when, about eight o'clock the following night, according to the Italian reckoning *, another violent ſhock ſucceeded, in which the waves roſe ſo high that they covered the whole ſhore, and out of more than a thouſand perſons who were there collected, among whom was the Prince of Scilla himſelf, not one eſcaped to relate and mourn the fate of the reſt. The furious waves, ruſhing into the ſtrait, penetrated to the harbour of Meſſina, and nearly ſunk the veſſels there at anchor.

When I arrived oppoſite to the city, I began to ſee the fatal and ruinous effects of this dreadful earthquake. The curvature of the harbour was formerly embelliſhed, for the extent of more than a mile, with a continued range of ſuperb palaces, three ſtories in height, uſually called the *Palazzata*, inhabited by merchants and other perſons of opulence, which formed a kind

* About one in the morning.

of

of ſuperb amphitheatre. The upper ſtory, and a part of the ſecond, of theſe buildings were entirely thrown down, the lower greatly torn and damaged, and the whole of this extenſive pile deſerted by its inhabitants.

When I entered the city, every object which met my view tended to awaken melancholy ſentiments and commiſeration. Excepting ſome of the wider and more frequented ſtreets, the reſt were all heaps of ruins, either piled up on each ſide, or ſcattered in the middle, and rendering it impoſſible to paſs them. Many of the houſes were ſtill in the ſame ruinous ſtate in which they had been left by the earthquake; ſome entirely deſtroyed and levelled with the ground, others half thrown down, and others ſtill ſtanding, or rather hanging in the air, merely from the ſupport afforded by the ruins around them. Thoſe which had eſcaped this deſtruction appeared as if preſerved by a miracle, torn and rent as they were. The cathedral was among the number of theſe fortunate edifices. This is a

ſpacious

ſpacious building, of gothic architecture. Its interior has ſuffered little or no damage. It is embelliſhed with a number of columns of granite brought from an ancient Grecian temple, which once ſtood on the Faro (or Strait of Meſſina), and with elegant Moſaic work wrought with the moſt beautiful jaſpers of Sicily.

The deſtruction of ſo great a number of houſes as were thrown down by this dreadful earthquake obliged the people of Meſſina to take refuge in wooden ſheds built for the occaſion, many of which were ſtill ſtanding when I was there. They had begun, however, to rebuild the houſes, but on a different plan from the old ones. They had obſerved that the higheſt had ſuffered moſt, and that, in the violent ſhocks of the earthquake, the beams, by continually and forcibly beating againſt the walls, had completed the ruin of the edifice. They therefore reſolved to build them lower, and to conſtruct the wood-work in ſuch a manner, that, in caſe of a ſimilar viſitation, the

ſhock

ſhock ſhould be ſuſtained by the whole of the building, and not by a part only. This precaution, it is evident, muſt be of the greateſt utility, ſhould the city again ſuffer a calamity of this nature.

Though it was now nearly the ſixth year ſince that dreadful diſaſter, conſiderable remains of the dread, conſternation, and, I may ſay, ſtupefaction, which uſually accompany great terrors were ſtill manifeſt in the minds of the people of Meſſina. They had ſtill preſent in their memory all the circumſtances of that dreadful time; nor could I liſten to the narrative they gave of them without ſhuddering.

That ancient city, which had ſo repeatedly ſuffered, was not deſtroyed by one but ſeveral earthquakes, which laſted in ſucceſſive ſhocks, from the 5th to the 7th of February 1783. The moſt deſtructive was that of the 5th, but an interval of ſome minutes elapſing between the firſt and ſecond ſhock, the inhabitants had time to

quit

quit their houſes, and fly to the open plain. Hence the number of thoſe who were killed was not proportionate to the quantity of ruins. They did not exceed eight hundred.

In a memoir relative to the earthquakes in that part of Calabria oppoſite to Meſſina, which happened at the ſame time, it is ſaid that, before the firſt ſhock, the dogs in the city began to howl violently, and were killed by a public order. On my enquiring of the people of the country, they aſſured me that the fact was falſe, and that no other phenomenon preceded this calamity but the flight of the ſea-mews and ſome other birds from the ſea to the mountains, as they uſually do on the approach of a tempeſt. A very violent noiſe, reſembling that of a number of carriages rattling over a ſtone-bridge, was the firſt ſymptom, while at the ſame time a thick cloud aroſe from Calabria, which was the centre of the earthquake, the propagation of which was ſucceſſively apparent by the fall of buildings from the point of the Faro to the city of Meſſina, as if at that point a mine

mine had been fired which extended along the ſhore and continued into the city. The ſhock was moſt violent, and the motion extremely irregular. In no part were any fire or ſparks obſerved. The ground along the ſhore opened in fiſſures parallel to it; and though in ſome places theſe continued more than a month, the dread and conſternation with which every one was ſeized, prevented any attempt to meaſure them.

After the firſt ſhock, which, as we have ſaid, took place about noon, on the 5th of February, the earth continued inceſſantly to tremble, ſometimes with a ſlighter and ſometimes a more violent motion; till at eight the following night another tremendous ſhock, which was fatal to the people of Scilla, completed the deſtruction of the remainder of the fabrics of Meſſina. The earthquakes did not ceaſe till the 7th, when another dreadful ſhock ſpent its rage upon the ruins.

From that time till my arrival at Meſſina,

ſhocks have continued to be felt, but gradually diminiſhing in force and number; and in 1789 and 1790, only four or five were obſerved, and thoſe ſo extremely feeble, that, in any other country leſs affected by fear and alarm, they might not have been noticed, or not ſuppoſed to be earthquakes*.

The loſs was immenſe, and is difficult to calculate. Conſidering the buildings alone, it may be aſſerted without heſitation, that, dividing

* In the following years, however, earthquakes again renewed the terrors of the people. The following is the extract of a letter from the Abbate Grano to me, of the 11th of May, 1792:

"Yeſterday we had a whole day, as I may ſay, full "of earthquakes. I counted as many as thirty ſhocks, "but all ſlight, and which occaſioned no damage."

I embrace with the utmoſt pleaſure this opportunity of thus publicly expreſſing my gratitude to and doing juſtice to the merits of this my illuſtrious friend, the Meſſineſe nobleman abovementioned, and whom I ſhall again have occaſion to cite.

As he is verſed in the ſtudies of philoſophy and natural hiſtory, he had the goodneſs to accompany me in my excurſions in different parts of his country, and his ſcientific

dividing them into four parts, two were levelled with the ground; the third half laid in ruins, and the fourth greatly damaged. Among the latter were the houſes ſituated on the declivity of the hills, which have for their foundation granite, as we ſhall notice again in another place (Chap. XXIX). Thoſe which were moſt completely ruined, and likewiſe the firſt to fall, were ſuch as ſtood in the plain, and eſpecially on the curvature of the harbour, on a ground leſs ſolid, as it had been formed by the waſhing and depoſitions of the ſea. The mole of the harbour, which extended more than a mile in length, and was reſorted to for the beauty of the pro-

ſcientific aſſiſtance was of the greateſt advantage to me. This aſſiſtance he not only afforded me when preſent, but even when abſent, furniſhing me with various local notices which might render my accounts relative to thoſe countries more intereſting; and his induſtry and circumſpection in the examination of nature, and his ſincere love of the inveſtigation of truth, leave no doubt of the accuracy of his obſervations.

ſpect, was entirely ſwallowed up by the ſea, ſo that no veſtige of it remained to point out where it once was.

Among the ruined edifices the moſt conſiderable were the abovementioned *Palazzata*, called likewiſe the maritime theatre; the royal palace; the palace of the ſenate, of noble architecture; the exchange of the merchants; the celebrated college, with the temple annexed; the church and profeſſional-houſe of the ex-jeſuits; the archbiſhop's palace, with the baſilica of San. Niccolo; the ſeminary of the clergy, the hall of the tribunals, the church of the annunciation of the Theatines; that of the Carmelites, and of the priory of the Hieroſolymitans, with ſeveral other fabrics both ſacred and profane; without mentioning the palaces of the nobles and opulent citizens, all of an elegant architecture.

It is impoſſible to eſtimate the loſs ſuffered by the deſtruction of the numerous monuments of the arts, libraries, and galleries of pictures,

pictures, with which Meſſina was embelliſhed, where the imitative arts had long flouriſhed.

Equally impoſſible is it to calculate the loſs ſuſtained by the valuable effects that were buried beneath the ruins, or burned in the fires which after the earthquake broke out in various parts of the city. We muſt alſo add the expence of building the wooden ſheds and huts neceſſary to ſhelter the inhabitants, and for the reception of ſuch moveables or commodities as had been ſaved from the ruins; which expence was extremely great from the high price to which all the materials for building immediately roſe, and the great wages required by workmen of every kind.

Yet, notwithſtanding all theſe loſſes and expences, which muſt greatly have impoveriſhed the country, not a ſingle merchant became a bankrupt; a circumſtance which redounds highly to the honour of Meſſina, as it is certain that no event can happen

which furniſhes a more plauſible excuſe to the fraudulent dealer than an earthquake.

The King of the Two Sicilies has omitted no means that may contribute to the reſtoration of Meſſina. He has exempted it from all public impoſts, given conſiderable ſums from his own purſe, granted a free port, juriſdiction of magiſtrates, &c. Yet the immenſe loſſes the city has ſuffered, notwithſtanding every aſſiſtance, cannot be repaired under a great length of time.

The buildings have ſince been conſiderably increaſed and improved, ſo that more than one half of the city is now rebuilt, and the people have left the ſheds and taken poſſeſſion of the new houſes.

It appeared to me that this conciſe relation of the late dreadful earthquakes at Meſſina, and their conſequences, would be acceptable to the curious and learned reader. We will now proceed to the deſcription of other objects deſerving attention in this celebrated ſtrait and its mountainous environs.

CHAP.

CHAP. XXVI.

OBSERVATIONS ON SCYLLA AND CHARYBDIS.

A kind of confuſed noiſe, like the barking of dogs, heard on approaching the rock of Scylla, produced by the daſhing of the waves of the ſea—Images highly reſembling nature exhibited by Homer and Virgil in their perſonifications of Scylla—The appearance of this rock the ſame at preſent as in the time of the Greek poet—The ſea there of the ſame height as formerly—Great danger of daſhing on the rock of Scylla when the current runs from ſouth to north, and an impetuous ſouth wind blows at the ſame time—Mariners at Meſſina, whoſe buſineſs it is to aſſiſt veſſels in danger—Ships eaſily wrecked without this aſſiſtance, though thoſe who ſteer them ſhould be very expert ſeamen—Tempeſt ob-

ſerved by the author in the Strait of Meſſina, and the courage with which theſe Meſſineſe ſailors brought a veſſel in diſtreſs ſafely into the harbour—Preciſe ſituation of Charybdis—Until the preſent time conſidered as a true whirlpool—The fragments of ſhips ſwallowed up in it carried, as ſome have believed, thirty miles—Anecdote relative to this opinion—Phenomena of the current of the Strait, which aſcends and deſcends by intervals—Viſit of the author to Charybdis—Its appearance as firſt ſeen from the ſhore—Obſervations made on a nearer approach, and on entering it in a boat—Charybdis not properly a whirlpool, but an inceſſant motion of agitated waters, which aſcend, deſcend, daſh and rebound—Conſequences which followed on throwing certain bodies into it—No gulph below Charybdis—Depth of the ſea much leſs there than in the middle of the Strait—Charybdis cannot even be called a whirlpool in tempeſtuous weather—Cauſe of the loſs of ſhips that are drawn into it—Recent ſhipwreck which happened in it without any appear-

ance of a whirlpool—Origin of this error —None of the numerous writers who have mentioned Charybdis, ſay that they had viſited and examined it—Charybdis twelve miles diſtant from Scylla, though Homer ſtyles it very near—Improbable that any ſuch change can have taken place in the Strait of Meſſina, as to have removed Charybdis ſo far from Scylla—Change that has happened in the preſent age, much poſterior to the date of the accounts of a number of writers who place Charybdis in the ſituation where it is now found—Truth and phyſical explanation of the proverb, that "he who endeavours to ſhun Charybdis "daſhes upon Scylla"—Scylla and Charybdis, according to the ancients, dangerous from frequent tempeſts and ſhipwrecks—Very different in the preſent times—Enquiry into the cauſe of this difference—It probably is to be aſcribed to the improvements made in the art of navigation—Examples in proof of this afforded by the Adriatic and the Cape of Good Hope.

SCYLLA and Charybdis, according to the fables of the poets, are two ſea-monſters whoſe dreadful jaws are continually diſtended to ſwallow unhappy mariners; the one ſituated on the right, and the other on the left extremity of the Strait of Meſſina, where Sicily fronts Italy.

Dextrum Scylla latus, lævum implacata Charybdis
Obſidet, atque imo barathri ter gurgite vaſtos
Sorbet in abruptum fluctus, rurſuſque ſub auras
Erigit alternos, et ſidera verberat unda.
At Scyllam cæcis cohibet ſpelunca latebris
Ora exertantem, et naves in ſaxa trahentem.
Prima hominis facies et pulchro pectore virgo
Pube tenus; poſtrema immani corpore priſtis
Delphinûm caudas utero commiſſa luporum.

VIRG. ÆNEID. lib. iii.

Far on the right her dogs foul Scylla hides;
Charybdis roaring on the left preſides,
And in her greedy whirlpool ſucks the tides.
Then ſpouts them from below; with fury driv'n,
The waves mount up and waſh the face of heav'n.
But Scylla from her den, with open jaws,
The ſinking veſſel in her eddy draws,
Then daſhes on the rocks: a human face,
And virgin boſom, hide her tail's diſgrace;

Her

Her parts obſcene below the waves deſcend,
With dogs inclos'd, and in a dolphin end.

DRYDEN.

I have no difficulty in availing myſelf of the deſcription of a poet in a work dedicated to the inveſtigation of truth; nor ſhall I heſitate to cite ſimilar paſſages from another poet; ſince, however exaggerated theſe may be by the glowing colours of imagination, they contain truth, and afford a ſubject for intereſting enquiries.

I ſhould have thought myſelf to have merited the greateſt cenſure, if, when I was in the Strait of Meſſina, I had not viſited two places of which ſo much has been written, and which have been rendered ſo famous by the numerous ſhipwrecks they have occaſioned.

I firſt proceeded in a ſmall boat to Scylla. This is a lofty rock, diſtant twelve miles from Meſſina, which riſes almoſt perpendicularly from the ſea, on the ſhore of Calabria, and beyond which is the ſmall city of the

the ſame name. Though there was ſcarcely any wind, I began to hear, two miles before I came to the rock, a murmur and noiſe, like a confuſed barking of dogs, and on a nearer approach readily diſcovered the cauſe. This rock in its lower part contains a number of caverns; one of the largeſt of which is called by the people there *Dragara*. The waves, when in the leaſt agitated, ruſhing into theſe caverns, break, daſh, throw up frothy bubbles, and thus occaſion theſe various and multiplied ſounds. I then perceived with how much truth and reſemblance of nature Homer and Virgil, in their perſonifications of Scylla, had pourtrayed this ſcene, by deſcribing the monſter they drew as lurking in the darkneſs of a vaſt cavern, ſurrounded by ravenous, barking, maſtiffs, together with wolves to increaſe the horror.

Ἐνθα δ᾽ εν Σκυλλη ναιει δεινον λελακυια
Της ητοι φωνη μεν ὁση σκυλακος νεογιλης
Γινεται.

HOM. ODYSS. XII.

Here Scylla bellows from her dire abodes,
Tremendous peſt! abhorr'd by man and gods!

Hideous

Hideous her voice, and with leſs terrors roar
The whelps of lions in the midnight hour!

POPE.

The Greek Poet, when he pourtrays the rock which is the habitation of Scylla, finiſhes the picture higher than the Latin, by repreſenting it as ſo lofty that its ſummit is continually wrapped in the clouds; and ſo ſteep, ſmooth, and ſlippery, that no mortal could aſcend it, though he had twenty hands and twenty feet.

Οι δε δυω σκοπελοι, ὁ μεν ουρανον ευρυν ικανει
Ὀξειη κορυφη νεφελη δε μιν αμφιβεβηκε
Κυανεη το μεν ουποτ' ἐρωει ουδεποτ' αιθρη
Κεινου εχει κορυφην, ουτ' εν θερει, ουτ' εν οπωρῃ
Ουδε κεν αμβαιη βροτος ανηρ ου καλαβαιη
Ουδ' ει οι χειρες γε εεικοσι, και ποδες ηεν
Πετρη γαρ λις εστι περιξεστη εικυια.

HOM. OD. XII.

High in the air the rock its ſummit ſhrowds
In brooding tempeſts and in rolling clouds;
Loud ſtorms around, and miſts eternal riſe,
Beat its bleak brow, and intercept the ſkies.
When all the broad expanſion bright with day
Glows with th' autumnal or the ſummer ray:
The ſummer and the autumn glow in vain;
The ſky for ever low'rs, for ever clouds remain.

Impervious

Impervious to the ſtep of man it ſtands;
Though borne by twenty feet, though arm'd with twenty hands.
Smooth as the poliſh of the mirror riſe
The ſlippery ſides, and ſhoot into the ſkies.

POPE.

Such, three thouſand years ago, or nearly ſo, appeared the rock of Scylla, according to the obſervations of Homer; and ſuch is nearly its appearance at this day.

The accuracy of this truly "firſt great painter of antiquity," which has likewiſe been obſerved by ſcientific travellers in other deſcriptions which he has given, ſhews that the level of the waters of the ſea was at that time at nearly the ſame height as at preſent, ſince, had it ſunk only a few fathom, it muſt have left the foot of the rock, which according to my obſervations is not very deep, entirely dry. And this I conſider as one among ſeveral ſtrong arguments, that the moſt remarkable ſinkings of the ſea are anterior to the time of Homer.

Such is the ſituation and appearance of Scylla;

Scylla: let us now conſider the danger it occaſions to mariners. Though the tide is almoſt imperceptible in the open parts of the Mediterranean, it is very ſtrong in the Strait of Meſſina, in conſequence of the narrowneſs of the channel, and is regulated, as in other places, by the periodical elevations and depreſſions of the water. Where the flow or current is accompanied by a wind blowing the ſame way, veſſels have nothing to fear; ſince they either do not enter the Strait, both the wind and the ſtream oppoſing them, but caſt anchor at the entrance; or, if both are favourable, enter on full ſail, and paſs through with ſuch rapidity that they ſeem to fly over the water. But when the current runs from ſouth to north, and the north wind blows hard at the ſame time, the ſhip which expected eaſily to paſs the Strait with the wind in its ſtern, on its entering the channel is reſiſted by the oppoſite current, and, impelled by two forces in contrary directions, is at length daſhed on the rock of Scylla, or driven on the neighbouring ſands; unleſs the pilot ſhall apply for

the ſuccour neceſſary for his preſervation. For, to give aſſiſtance in caſe of ſuch accidents, four-and-twenty of the ſtrongeſt, boldeſt, and moſt experienced ſailors, well acquainted with the place, are ſtationed night and day along the ſhore of Meſſina; who, at the report of guns fired as ſignals of diſtreſs from any veſſel, haſten to its aſſiſtance, and tow it with one of their light boats. The current, where it is ſtrongeſt, does not extend over the whole Strait, but winds through it in intricate meanders, with the courſe of which theſe men are perfectly acquainted, and are thus able to guide the ſhip in ſuch a manner as to avoid it. Should the pilot, however, confiding in his own ſkill, contemn or neglect this aſſiſtance, however great his ability or experience, he would run the moſt imminent riſk of being ſhipwrecked. In this agitation and conflict of the waters, forced one way by the current, and driven in a contrary direction by the wind, it is uſeleſs to throw the line to diſcover the depth of the bottom; the violence of the current frequently carrying the lead almoſt

on

on the ſurface of the water. The ſtrongeſt cables, though ſome feet in circumference, break like ſmall cords. Should two or three anchors be thrown out, the bottom is ſo rocky, that they either take no hold, or, if they ſhould, are ſoon looſened by the violence of the waves. Every expedient afforded by the art of navigation, though it might ſucceed in ſaving a ſhip in other parts of the Mediterranean, or even the tremendous ocean, is uſeleſs here. The only means of avoiding being daſhed againſt the rocks, or driven upon the ſands, in the midſt of this furious conteſt of the winds and waves, is to have recourſe to the ſkill and courage of theſe Meſſineſe ſeamen.

In proof of the truth of this aſſertion, I might adduce many inſtances related to me by perſons deſerving of credit. But I was myſelf an eye-witneſs to the ſituation of a trading veſſel from Marſeilles, which had one day entered the Strait by the mouth on the north ſide, at the time that I was on a hill looking towards the ſea. The current,

and

and a north wind, which then blew ſtrong, being both in its favour, the veſſel proceeded under full ſail into, and had paſſed one half of, the Strait, when, on a ſudden, the ſky became overcaſt with thick clouds, and violent guſts of wind aroſe, which in an inſtant changed the direction of the current, and turned up the ſea from its bottom. The mariners had ſcarcely time to hand the ſails, while the furious waves broke over the ſhip on every ſide. Whether they merely followed the practice uſual with ſhips in diſtreſs, or whether they were acquainted with the laudable cuſtom of the Meſſineſe, I cannot ſay; but they fired two guns: immediately upon which one of the barks employed on this ſervice haſtened to the aſſiſtance of the diſtreſſed veſſel, and, taking it in tow, began to make every exertion to carry it ſafely into the harbour.

If I had ſeen with fear and ſhuddering the danger of the ſailors on board the veſſel, which I expected every moment would be ſwallowed up in the waves; I beheld with wonder

wonder and pleaſure the addreſs and bravery of the Meſſineſe mariners, who had undertaken to ſteer ſafely through ſo ſtormy a ſea the ſhip entruſted to their care. They extricated it from the current which impelled it towards deſtruction; changed the helm to this ſide or to that; reefed or let out the ſails, as the wind increaſed or abated; avoided the impetuous ſhocks of the waves by meeting them with the prow, or oppoſing to them the ſide, as either method appeared moſt proper to break their violence; and by theſe and other manœuvres which I am unable to deſcribe, theſe brave mariners, amid this dreadful conflict of the ſea and the winds, ſucceeded in their undertaking, and brought the veſſel ſafe into the harbour.

But enough of Scylla:—we will now proceed to Charybdis. This is ſituated within the Strait, in that part of the ſea which lies between a projection of land named *Punta Secca*, and another projection on which ſtands the tower called *Lanterna*, or the light-houſe, a light being placed at

its top to guide veſſels which may enter the harbour by night.

On conſulting the authors who have written of Charybdis, we find that they all ſuppoſed it to be a whirlpool. The firſt who has aſſerted this is Homer, who has repreſented Charybdis as a monſter which three times in a day drinks up the water, and three times vomits it forth.

—— δια Χαρυβδις αναρροιβδει μελαν ὑδωρ,
Τρις μεν γαρ τ'ανιησιν επ' ἠμαῖι, τρις δ'αναρροιβδει
Δεινον. HOM. ODYSS. XII.

Beneath Charybdis holds her boiſterous reign
Midſt roaring whirlpools, and abſorbs the main;
Thrice in her gulphs the boiling ſeas ſubſide,
Thrice in dire thunders ſhe refunds the tide.
POPE.

The deſcription of Virgil, above cited, differs from that of Homer only in placing a deep gulph below. Strabo, Iſidorus, Tzetzes, Heſychius, Didymus, Euſtathius, &c. repeat the fame. The Count de Buffon adopts the idea of Homer in full confidence, and places Charybdis among the moſt celebrated

brated whirlpools of the ſea. "Charybdis, "in the Strait of Meſſina, abſorbs and re- "jects the water three times in twenty-four "hours *." Strabo tells us, that the fragments of ſhips ſwallowed up in this whirlpool are carried by the current to the ſhore of Tauromenium (the preſent Taormina) thirty miles diſtant from Charybdis †. In confirmation of this tradition, an amuſing though tragical anecdote is related of one Colas, a Meſſinean diver, who, from being able to remain a long time under the water, had acquired the ſurname of *Peſce* (the fiſh). It is reported that Frederic King of Sicily, coming to Meſſina purpoſely to ſee him, made trial of his abilities with a cruel kind of liberality, by throwing a golden cup into Charybdis, which, if he brought it up, was to be the reward of his reſolution and dexterity. The hardy diver, after having twice aſtoniſhed the ſpectators by remaining under

* Buffon, Hiſt. Nat. tom. ii. in 12mo.

† Καταποθεντων δε και διαλυθεντων τα ναυαγια, παρασυρεται προς ηιονα της Ταυρομενιας. Lib. VI.

water a prodigious length of time, when he plunged the third time appeared no more; but, ſome days after, his body was found on the coaſt near Taormina.

From the authorities here adduced, it is evident that Charybdis has hitherto been conſidered as a real whirlpool by both ancient and modern travellers who have given any account of it.

As I was, therefore, ſo near to this celebrated place, I determined to endeavour to aſcertain, if poſſible, what it really is. It is diſtant from the ſhore of Meſſina about 750 feet, and is called by the people of the country *calofaro*, not from the agitation of the waves, as ſome have ſuppoſed, but from καλος and φαρος; i. e. *the beautiful tower*, from the light-houſe erected near it for the guidance of veſſels. The phenomenon of the calofaro is obſervable when the current is deſcending; for when the current ſets in from the north, the pilots call it the *deſcend-*

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ing rema *, or current; and when it runs from the ſouth, the *aſcending rema*. The current aſcends or deſcends at the riſing or ſetting of the moon, and continues for ſix hours. In the interval between each aſcent or deſcent there is a calm which laſts at leaſt a quarter of an hour, but not longer than an hour. Afterwards, at the riſing or ſetting of the moon, the current enters from the north, making various angles of incidence with the ſhore, and at length reaches the calofaro. This delay ſometimes continues two hours. Sometimes it immediately falls into the calofaro, and then experience has taught that it is a certain token of bad weather.

As I was aſſured by the pilots moſt experienced in this practical knowledge, that

* I have obſerved that at Meſſina, as well as in other parts of Sicily, words of the Greek language, which was once that of this iſland, are ſtill retained. Thus the word *rema*, derived from ῥευμα, a flowing or ſtream, is uſed to ſignify the current of this Strait.

there was no danger in viſiting the calofaro, I reſolved to avail myſelf of the opportunity. The bark in which I made the excurſion was managed by four expert mariners, who, perceiving me ſomewhat intimidated as I approached the place, encouraged me, and aſſured me they would give me a very near view of the calofaro, and even carry me into it without the leaſt danger.

When I obſerved Charybdis from the ſhore, it appeared like a group of tumultuous waters; which group, as I approached, became more extenſive and more agitated. I was carried to the edge, where I ſtopped ſome time to make the requiſite obſervations, and was then convinced, beyond the ſhadow of a doubt, that what I ſaw was by no means a vortex or whirlpool.

Hydrologiſts teach us that by a whirlpool in a running water we are to underſtand that circular courſe which it takes in

certain circumſtances; and that this courſe or revolution generates in the middle a hollow inverted cone, of a greater or leſs depth, the internal ſides of which have a ſpiral motion. But I perceived nothing of this kind in the calofaro. Its revolving motion was circumſcribed to a circle of at moſt an hundred feet in diameter, within which limits there was no incurvation of any kind nor vertiginous motion, but an inceſſant undulation of agitated waters, which roſe, fell, beat, and daſhed on each other. Yet theſe irregular motions were ſo far placid, that nothing was to be feared in paſſing over the ſpot, which I did; though our little bark rocked very much, from the continual agitation, ſo that we were obliged conſtantly to make uſe of our oars to prevent its being driven out of the calofaro. I threw ſubſtances of different kinds into the ſtream. Such as were ſpecifically heavier than the water, ſunk and appeared no more; thoſe which were lighter remained on the ſurface, but were ſoon driven out of the revolving circle by the agitation of the water.

Though from theſe obſervations I was convinced that there was no gulph under the calofaro; as otherwiſe there would have been a whirlpool, which would have carried down into it the floating ſubſtances; I determined to ſound the bottom with the plummet, and found its greateſt depth did not exceed five hundred feet. I was likewiſe informed, to my no ſmall ſurpriſe, that, beyond the calofaro, towards the middle of the Strait, the depth was double.

I could not, therefore, but conclude from theſe facts, that, at that time, there was no whirlpool in Charybdis. I ſay *at that time*, ſince the caſe might be very different when the ſea was tempeſtuous. I therefore made enquiry relative to this of the pilots, thoſe, eſpecially, who, from their tried experience, were appointed by the public to give aſſiſtance in ſtorms to foreign veſſels, and who had frequently ſeen Charybdis in its greateſt fury. The following is the ſubſtance of the anſwers they gave me:—

When

When the current and the wind are contrary to each other, and both in their greateſt violence, eſpecially when the ſcilocco, or ſouth wind, blows; the ſwelling and daſhing of the waves within the calofaro is much ſtronger, more impetuous, and more extenſive. It then contains three or four ſmall whirlpools, or even more, according to the greatneſs of its extent and violence. If at this time ſmall veſſels are driven into the calofaro by the current or the wind, they are ſeen to whirl round, rock, and plunge; but are never drawn down into the vortex. They only ſink when filled with water by the waves beating over them. When veſſels of a larger ſize are forced into it, whatever wind they have they cannot extricate themſelves; their ſails are uſeleſs; and after having been for ſome time toſſed about by the waves, if they are not aſſiſted by the pilots of the country, who know how to bring them out of the courſe of the current, they are furiouſly driven upon the neighbouring ſhore of the Lanterna, where they

are

are wrecked, and the greater part of their crews periſh in the waves*.

If we conſider maturely theſe facts, we ſhall find that a great part of what has been written relative to Charybdis is very erroneous. We have ſeen how many authors, from Homer to the preſent time, have de-

* The following account of the ſhipwreck of a veſſel in the calofaro was ſent me, after my return from Sicily, by the Abbate Grano from Meſſina:

"About three weeks ago, we were ſpectators of the ſinking of a Neapolitan polacca in the calofaro, on its paſſage from Puglia, laden with corn. A moſt violent ſouth-eaſterly wind blew, and the veſſel, with all ſails ſet, endeavoured to reach the harbour, ſtanding off from the calofaro; but the head of the current from the entrance by the faro took her, and drew her impetuouſly into it; where, without being able to make uſe of her ſails, ſhe remained for ſome time toſſed about by the waves, which, at length, either breaking over her, or opening her ſides by their furious beating, ſent her to the bottom. The crew, however, and a part of the cargo, were ſaved by the ſpeedy aſſiſtance given by our mariners in two ſmall barks, who had the courage to encounter the danger. You will perceive, from this, in what manner the waves may ſink ſhips in Charybdis, without the neceſſity of ſuppoſing a whirlpool."

ſcribed

ſcribed it as a real whirlpool, or great gulph revolving in itſelf, within the circumference of which ſhould any ſhip enter it is immediately drawn to the centre and ſwallowed up. When the current is dying away, or when there is no current, this deſcription has no reſemblance to truth—Charybdis is then perfectly innocent, as I have been fully convinced by my own obſervations; and even when it is agitated and dangerous, it ſtill contains no incavation or gulph of the nature of a vortex, but merely a ſtrong agitation and daſhing of its waves, which produces thoſe ſmall whirlings of its waters, which are only accidental, and not to be feared. So far likewiſe is Charybdis from drawing to itſelf and ſwallowing veſſels, that it rather repels them and throws them to a diſtance.

This error has ariſen like many others with reſpect to the productions of nature. Homer, in relating the voyage of Ulyſſes through the Strait of Meſſina, was the firſt who deſcribed Charybdis as an immenſe vortex

vortex which abſorbs and rejects the water, and the ſhips that approach it; exemplifying his account by the fate of ſome of the companions of his hero, who were carried away by the whirlpool. The writers who came after him, whether poets, orators, hiſtorians, or geographers, have followed him in this deſcription; without any one of them taking the pains to repair to the place and examine it himſelf. Even Fazello the Sicilian, who was ſo induſtrious in aſcertaining facts, and whoſe accounts of his country are ſo accurate, clearly ſhews in his deſcription of Charybdis that he had never obſerved it himſelf; and concludes his narration with the erroneous ſuppoſition above cited, that the things ſwallowed up by Charybdis are conveyed by ſubmarine currents to the ſhores of Taormina.

Among all who have written on this ſubject, we only find Cluverius who ſeems, at leaſt at firſt view, to have viſited the place. I ſhall tranſcribe his words:

"Ego

" Ego ſane, cum Charybdis noſcendæ gra-
" tia aliquot dies Meſſanæ ſubſiſterem, et ab
" hominibus ejus loci, maximè vero nautis,
" non Siculis modo, ſed et Belgis, Britannis
" et Gallis, qui hoc fretum frequentes navi-
" gant, diligentius eam rem ſciſcitarer, nihil
" omnino certi ipſis perdiſcere potui, adeo
" ſcilicet totum negotium omnibus obſcu-
" rum et incognitum erat. Tandem tamen
" reperi Charybdim, quæ incolis, patriis vo-
" cabulis, dicitur *Calofaro*, ſub prædicta ad
" Meſſanenſem portum pharo eſſe mare ra-
" pide fluens, atque in vortices actum : quod
" non τρις επ' ἡμαϑι ut tradit Homerus, id
" eſt *ſingulis diebus ter*, abſorbet ingenti gur-
" gite, revomitque aquas, ſed quoties vehe-
" mentiori fluctu fretum comitatur."

" I remained ſome days at Meſſina, with
" a view to obtain ſome information relative
" to Charybdis ; but though I made every
" enquiry of the people of the place, and
" principally the ſailors, not the Sicilian
" only, but the Italian, Dutch, Engliſh and
" French, who frequently navigate that
" ſtrait,

" ſtrait, I could learn nothing ſatisfactory—
" ſo little was known by them on the ſub-
" ject. At length, however, I found Cha-
" rybdis, which the natives call *Calofaro*,
" under the light-houſe before mentioned,
" near the harbour, to be a ſea rapidly flow-
" ing, and forming vortices. It does not
" abſorb the waters in its vaſt gulph, and re-
" ject them *thrice in a day*, as Homer tells
" us, but as often as the ſea runs high in the
" Strait."

From the expreſſion " I found Charyb-
" dis" we might be induced to believe that he made his obſervations on the ſpot. It is certain, however, that he does not explicitly tell us ſo: and, when treating of a phenomenon of which he was ſo anxious to obtain an accurate knowledge, which he could not procure even from the Meſſineſe ſailors, it is ſtrongly to be preſumed that he would not have ſuppreſſed a circumſtance of that importance. As Charybdis may be ſeen from the ſhore, if he only went thither, and turned his eyes towards it, he might

with

with truth aſſert he had diſcovered it. The other adjuncts to his account, that Charybdis is a rapid ſea, and that it abſorbs and rejects the water in a ſtorm, convince me that he had not a juſt idea of it, but ſatisfied himſelf with the old tradition concerning Charybdis.

It may be obſerved that the ſituation of Charybdis, as it has been hitherto deſcribed, does not exactly agree with that aſſigned it by Homer. Let us refer to the Poet: The goddeſs Circe gives the following directions to Ulyſſes, with reſpect to the navigation of the Strait of Meſſina:

Οι δε δυω σκοπελοι, ὁ μεν ουρανον ευρυν ικανει . . . .
Τον δ'ἑτερον σκοπελον χθαμαλωτερον οψει Οδυσσευ,
Πλησιον αλληλων και κεν διοιστευσειας.
Τῳ δ'εν 'ερινεος 'εστι μεγας φυλλοισι τεθηλως,
Τῳ δ'ὑπο δια Χαρυβδις αναῤῥοιβδει μελαν ὑδωρ.

HOM. ODYSS. XII.

High o'er the main two rocks exalt their brow . . . .
Cloſe by, a rock of leſs enormous height
Breaks the wild waves, and forms a dangerous ſtreight;
Full on its crown a fig's green branches riſe,
And ſhoot a leafy foreſt to the ſkies;

Beneath,

Beneath, Charybdis holds her boiſt'rous reign
Midſt roaring whirlpools, and abſorbs the main.
POPE.

The firſt of the rocks here mentioned by Homer is Scylla, which he deſcribes at length; and near the other, according to this poet, Charybdis is ſituated. The diſtance from one of theſe rocks to the other is an arrow's flight, ὴ κεν διοϊστεύσειας, which does not at all accord with the preſent ſituation of Scylla. How are we to explain this diſagreement? Shall we ſay that Homer, availing himſelf of the licence in which poets are indulged, has ſpoken hyperbolically? I know not whether the connoiſſeurs in poetry will permit ſuch a licence. Or ſhall we ſuppoſe that Charybdis was once much nearer to Scylla; but that in a long ſeries of ages, it has changed its place and removed under Meſſina? Such a ſuggeſtion might, perhaps, be favourably received, if in remote times any conſiderable change had taken place in the Strait; but we know not of any; and it is not probable that a change ſo remarkable as the removal of Charybdis

Charybdis from its place, would have been paſſed over in ſilence by Sicilian writers. Within the preſent century, it is true, this Strait, of which ſo much has been ſaid, has become narrower, as we ſhall ſee in Chap. XXIX; but, at the ſame time, we know that, long before this event, Charybdis was ſituated where it is at preſent. The ancient and uninterrupted tradition of the Meſſineſe reſpecting this fact is confirmed by the authority of the moſt celebrated Italian, Latin, and Greek writers—Fazello tells us, "Cha-" rybdis ex parte Siciliæ, paulo ſupra Meſ-" ſanam"—"Charybdis is ſituated on the "ſide of Sicily, a little beyond Meſſina."—Ovid ſays,

"Hinc ego dum muter, vel me Zanclæa Charybdis
Devoret!"

"Let dire Charybdis in Zanclæan ſeas
Devour me if I change!"

And it is well known that Zancle was the ancient name of Meſſana, now Meſſina. Tzetzes in Lycophron ſays, Ἡ Χαρυβδις περι Μεσηνην

Μεσσηνην εφι—" Charybdis is ſituated near " Meſſina."—Strabo, likewiſe, after having mentioned Meſſina, proceeds, Δακνυλαι δ' Χαρυβδις, μικρον προ της πολεως, εν τω πορθμω—" Charybdis is ſeen in the Strait " a little before we reach the city." Several other writers might be cited to the ſame purpoſe.

From all theſe reaſons and hiſtorical teſtimonies we muſt then conclude that Homer was not exact with reſpect to the ſituation of Charybdis; nor can it be a great offence to ſay that, in this paſſage of his long poem, he has certainly nodded. The accuracy of ſeveral of his deſcriptions of various places in Sicily cannot be denied. It is ſuch that we muſt either ſuppoſe that he had himſelf travelled in thoſe parts, as is the opinion of many; or, at leaſt, that he had procured very faithful and circumſtantial information from others. Of this the rocks of Scylla are an example. But, as to the ſuppoſed whirlpool of Charybdis, and its ſituation,

I think

I think we may venture to affirm he never ſaw it himſelf, and that the accounts he had received of it led him into error.

We will now enquire what foundation there is for the ſaying which became proverbial; that "he who endeavours to avoid Charybdis, daſhes upon Scylla;" and which was applied by the ancients to thoſe who, while they ſought to ſhun one evil, fell into a worſe.

On this ſubject I likewiſe made enquiries of the Meſſineſe pilots above mentioned, and to what better maſters could I apply for the elucidation of ſuch a proverb? They told me that this misfortune, though not always, yet frequently happens, unleſs proper meaſures are taken in time to prevent it. If a ſhip be extricated from the fury of Charybdis, and carried by a ſtrong ſoutherly wind along the Strait, towards the northern entrance, it will paſs out ſafely; but ſhould it meet with a wind in a nearly oppoſite direction, it will become the ſport of both theſe winds, and,

unable to advance or recede, be driven in a middle courſe between their two directions, that is to ſay, full upon the rock of Scylla, if it be not immediately aſſiſted by the pilots. They added, that in theſe hurricanes a land wind frequently riſes, which deſcends from a narrow paſs in Calabria, and increaſes the force with which the ſhip is impelled towards the rock.

Before I began to write on Scylla and Charybdis, I peruſed the greater part of the ancient authors who have written on the ſubject. I obſerve that they almoſt all repreſent theſe diſaſtrous places in the moſt gloomy and terrifying colours, as continually the ſcene of tempeſts and ſhipwrecks. Theſe terrors and this deſtruction, however, they are far from exhibiting in the preſent times; it rarely happening that any ſhips are loſt in this channel, either becauſe their pilots poſſeſs the knowledge requiſite for their preſervation, or becauſe they apply for the neceſſary aſſiſtance. Whence then ariſes this great difference between ancient times and the preſent?

preſent? Can we ſuppoſe that Scylla and Charybdis have changed their nature and become leſs dangerous? With reſpect to the former, we have ſeen that this hypotheſis is contradicted by fact; Scylla ſtill remaining ſuch as it was in the time of Homer; and with regard to the latter, from the Strait of Meſſina becoming narrower, Charybdis muſt be at preſent more to be feared than formerly, as it is well known that an arm, channel, or ſtrait of the ſea is the more dangerous in proportion as it is narrow. I am rather of opinion that this difference ariſes from the improvement of the art of navigation, which, formerly in its infancy, dared not launch into the open ſea, but only creep along the ſhore, as if holding it with its hand—

Alter remus aquas, alter tibi radat arenas,
Tutus eris; medio maxima turba mari.
PROPERT. lib. iii.

To ſhun the dangers of the ocean, ſweep
The ſands with one oar, and with one the deep.

But time, ſtudy and experience have

rendered her more mature, better informed, and more courageous ; ſo that ſhe can now paſs the wideſt ſeas, brave the moſt violent tempeſts, and laugh at the fears of her childhood.

To exemplify and ſupport the probability of this opinion, it will not be neceſſary to recur to the early and rude ages; much more modern times will furniſh us with ſufficient proofs. That part of the Adriatic which ſeparates Venice from Rovigno in Iſtria, is certainly not the moſt propitious ſea to navigators. The danger of being hurried in ſix hours from one ſhore to the other, and there ſtranded; the frequency of violent winds which prevail there ; the ſhallows and ſand-banks which break the waves, and render them wild and irregular ; may certainly cauſe ſome ſerious reflection in thoſe who embark to make the paſſage. So lately as the laſt century, the ſhipwrecks in this ſea were ſo numerous, and had ſo terrified the people of Rovigno, that, when any one was obliged by urgent buſineſs or any other

other cauſe to go to Venice, he conſidered himſelf as more likely to die than live; and, if he was the father of a family, uſed to make his will before he embarked. The Advocate Conſtantini, a native of that country, and a man of learning and ingenuity, told me when I was there, that he had read more than one of theſe teſtaments, depoſited among the public archives.

But, at preſent, I will not ſay it is a diverſion or pleaſure to make this paſſage, ſince, as ſtorms are not unfrequent, it is neceſſary to be cautious; but ſerious accidents rarely happen. I have myſelf three times made it without meeting with any cauſe of alarm. To what can this difference be attributed but to the improvement of the nautical art? Beſides that the mariners of Rovigno were not then ſo expert in the management of their veſſels as at preſent; they made uſe of certain barks of ſo improper a conſtruction, as I was aſſured by the abovementioned Conſtantini, that it was impoſſible they ſhould long reſiſt the vio-

lence of the ſea. Thoſe, on the contrary, that have been built ſince that time, being of a broad and flat figure, and very ſolid, are capable of withſtanding the moſt furious ſtorms. They are there called *bracere*, and are in great reputation in all the neighbouring countries. We here find a part of the ſea, in which veſſels were formerly ſo frequently wrecked, and which could not be traverſed but at the riſk of life, now deprived of all its terrors, and rendered eaſily paſſable, merely by the improvements made in the art of navigation.

As a farther and ſtill more convincing proof that the dangers of Charybdis and Scylla, though in themſelves the ſame that they anciently were, have been diminiſhed, and the dread they inſpired removed, by the rapid advances to perfection which this art has made in modern times; I ſhall adduce an example in another ſea no leſs an object of terror from tempeſts and ſhipwrecks, I mean the Cape of Good Hope, called the Stormy Cape by the firſt diſcoverer, and by the mariners

mariners of thoſe times the Raging Lion. How dreadful were the dangers of this place, where the two oceans deſcending down the oppoſite ſides of Africa met and claſhed together; where contending winds, whoſe power was greater in the boundleſs ocean; where mountainous waves, rocks, and whirlpools threatened inevitable deſtruction! What preparations, what caution, were thought neceſſary for the ſhip which was to make this dangerous paſſage! Able pilots who had frequently made the voyage; maſts and yards ſecured by additional ropes; a large ſupply of ſails and cables, thicker and ſtronger than uſual; and a double rudder, that, in caſe one ſhould be damaged, there might be another to act. The mariners were to be faſtened to their poſts by ſtrong ropes; the paſſengers ſhut down below, and the deck left clear for the crew; a number of whom ſtood with hatchets in their hands, ready to cut away the maſts ſhould it be neceſſary. The guns were ſtowed in the hold as ballaſt, and the port-holes, windows, and every kind of aperture, carefully cloſed. Such were

were the precautions taken in the laſt century on doubling the Cape of Good Hope; but how few of them are now neceſſary to perform this voyage in perfect ſafety! Of this I have had the ſatisfaction to be certified by an Engliſh gentleman, Mr. Macpherſon, with whom I had the pleaſure of converſing, in Pavia, in July 1790, and who had twice doubled this Cape in his voyages to India; a gentleman of great reſpectability for his information, for the various long voyages he has made, and the honourable employments he has held.

The facility with which this paſſage may now be made, is therefore the conſequence of the perfection to which the art of navigation has arrived; and the ſame we may conclude with reſpect to Charybdis and Scylla, which, at preſent, have nothing terrible but the name, to thoſe who paſs them with the requiſite precautions.

CHAP.

CHAP. XXVII.

PHOSPHORESCENT MEDUSÆ OBSERVED IN THE STRAIT OF MESSINA.

Origin of this name, as alſo of thoſe of ſea-jellies or ſea-nettles—Very few authors have written concerning them, and none attempted their complete hiſtory—The ſketch given by Læflingius more proper to excite than gratify curioſity—Great ſcarcity of phoſphoreſcent meduſæ compared with thoſe not phoſphoreſcent—A great number of them accidentally met with by the author in the Strait of Meſſina—Their organization and manner of ſwimming in the ſea neceſſary to be known to underſtand their phoſphoreſcence—The form of their body ſimilar to the umbella, or top, of a fungus, convex on the upper part, and concave in the under—Furniſhed with twelve tentacula or feelers

—The umbella of these medusæ thicker in the upper part—Aperture and cavity in the upper part of the umbella, which probably is the mouth and stomach of these animals—Extreme simplicity of this umbella—Parts in this cavity resembling intestines and tracheæ—Fine muscular membrane in the lower internal parts of the umbella—The tentacula or feelers described —No appearance of the circulation of the humours in these medusæ—They dissolve almost entirely into a salt liquor, the salt of which is found to be muriate of soda (sea-salt)—Sea-water forms the greater part of the substance of these animals—Proofs of organization even in those parts of the medusæ in which it is not apparent—The systole and diastole in the umbella of the medusæ the cause of their progressive motion in the sea—Without this alternate action they would sink to the bottom—The seat of their systole and diastole exclusively in the fine muscular membrane above mentioned—These motions not diminished by taking the medusa out of the water; but cease when

the

the muſcular membrane is dried or corrupts —Not abſolutely aſcertained by facts, whether the ſyſtole and diaſtole be independent of the will of the animal—Particular motions in the parts reſembling inteſtines and tracheæ in the cavity of the umbella—Conjecture that the former are real inteſtines— The phoſphoreſcence of the meduſæ and its phenomena obſerved by night in the ſea, and in veſſels filled with ſea-water—This greateſt during the ſyſtole, ſomewhat leſs in the diaſtole, and leaſt in the intervals of reſt—Does not entirely ceaſe till the meduſa is dead, and putrefaction commences—Methods which will render a very ſmall degree of it ſenſible—The ſame phenomena obſervable in dead meduſæ left in the dry— Meduſæ which are dead, almoſt entirely diſſolved into a liquor, and which no longer ſhine; if they are immerſed in freſh water, immediately become lucid, communicating their reſplendence to the water—The ſame appearance not obſervable if ſea-water be uſed —— Rain falling on meduſæ which are no longer phoſphoreſcent, reſtores their luminous appearance, which

cannot

cannot be effected by ſprinkling them with ſea-water, in imitation of rain—Friction not only increaſes the brightneſs of their light, but reſtores it when apparently extinguiſhed—By means of this friction the phoſphoreſcence may be communicated to water, but much more ſtrongly to freſh than to ſalt water—Beautiful phoſphoreſcences produced in well-water by ſqueezing ſome meduſæ in it—This phoſphoreſcence, when it had ceaſed, again appeared on ſhaking the water—Artificial heat more proper than that of the atmoſphere to reſtore the light of the water when agitation alone is inſufficient—Human urine, both with regard to the intenſity and duration of this phoſphoreſcence, not inferior to freſh water—No liquor in this exceeds milk—Pleaſing appearances produced by this phoſphoreſcent liquor when poured into a glaſs, or when the hand is plunged into it—This phoſphoreſcence in milk when loſt may be reſtored by throwing it forcibly againſt any hard body—Theſe phenomena more conſpicuous in milk than in other liquors—The phoſphoreſcence of theſe meduſæ

ſæ does not extend to the whole of their bodies—No appearance of light in the umbella except at the edges—The light very ſtrong in the larger tentacula, and feeble in the purſe that communicates with an aperture in the umbella, which, probably, is the mouth of the animal—This light diſcovered to reſide in a rather thick and adheſive humour, which moiſtens and covers the three parts above mentioned—This humour muſt be recent to be endowed with its luminous quality—Great difference between theſe meduſæ and others that the author had before obſerved in other ſeas, which do not become phoſphoreſcent till they putrefy and become fetid; directly contrary to what is obſervable in theſe—Theſe meduſæ contain two humours; the one in conſiderable abundance, ſalt, and not offenſive to the taſte; the other much leſs in quantity, acrid, nauſeous, and, when applied to the ſkin of the more tender parts of the body, cauſing a diſagreeable ſenſation—The meduſæ uſually frequent thoſe parts of the ſea that are calm—Different names by which

which they are known at Meſſina and in the Lipari iſlands—Probable that they feed on ſmall fiſh—Manner in which they take their prey—Conjecture that they are true hermaphrodites—A new ſpecies of meduſa characterized—Two kinds of ſea glow-worms obſerved by the author in his travels in Sicily, ſimilar to thoſe he had ſome years before noticed in the Gulph of Genoa, the Archipelago, and the Black Sea.

AMONG the animals which from their tenderneſs of body have been ranked by ſyſtematic naturaliſts in the order of Molluſca, there is a ſingular genus, well known to the ancients, and denominated by ſome moderns ſea-nettles, by Reaumur ſea-jellies, and by Linnæus meduſæ; appellations, all of which have an alluſion to ſome exterior character of theſe animals; it having been obſerved, that on touching them they produce a pungent ſenſation like the nettle; that, being handled, they diſſolve between the fingers like a jelly; and that, from their ſtrange form, they in ſome meaſure reſemble the head

head of the fabulous Meduſa. Ariſtotle, who wrote in Greece, and Pliny, who, long after, copied him in Italy, were the firſt who gave ſome imperfect accounts of the life and habits of theſe curious animals. I know of no authors who have ſince written on them, Reaumur and Dicquemare excepted. The former, in the Memoirs of the Royal Academy of Sciences at Paris for the year 1710, has conſidered, in an eſſay of ſome length, the manner in which the local motion of ſome ſpecies of meduſæ is effected; and the latter, in ſeveral memoirs in Rozier's *Journal de Phyſique*, has examined their organic ſtructure and various motions. Neither of theſe authors, however, has made any mention of a remarkable quality in theſe meduſæ; I mean, that they are phoſphoreſcent. I do not know that this ſpecies has hitherto been deſcribed: I only know that Lœflingius aſſerts that he had ſeen it, according to what Linnæus ſays in his *Amœnitates Academicæ* in the following words:

" Doctiſſimus Lœflingius, inter Hiſpaniam

" et Americam, vidit, in alto mari, meduſas
" aliaque zoophyta, pacatâ aquâ, diſperſa
" per æquora, et noctu inſtar totidem cande-
" larum lucere, et exortis ventis ſenſim ſub-
" ſidere et lucem ſuffocari."

" The learned Lœflingius ſaw in the ſea
" between Spain and America meduſæ, and
" other zoophyta, diſperſed over the water,
" when calm, and ſhining in the night like
" ſo many candles. When the wind roſe,
" they gradually ſank, and their light diſ-
" appeared."

But this account is much too conciſe and imperfect to be ſatisfactory, and ſerves rather to excite than gratify our curioſity. Nor am I ſurpriſed at the want of preciſe obſervations relative to this phoſphoreſcent quality, as the meduſæ which are poſſeſſed of it are extremely few compared with thoſe which are deſtitute of it. I had an opportunity of examining many of them in the ſea of Genoa, as alſo in the Adriatic, the Archipelago, and the Thracian Boſphorus;

but I did not find one which was luminous by night. I only met with these by a kind of fortunate accident in the Strait of Messina, and first discovered them when, after my excursion to the rock of Scylla, I returned to that city. As I remained there several weeks, not only to observe Charybdis and Scylla, but also the animals taken in the fisheries in that Strait, and the fossil productions of the mountains and hills in the vicinity, I had sufficient opportunity to examine and study this species of medusa, of which there are great quantities in this channel of the sea. But it is not possible to give the reader a clear and precise idea of this phosphorescence, without first briefly describing the organization of these animals, and the manner in which they swim in the water, and transfer themselves from place to place; both of which have a direct and immediate relation with their luminous quality.

With respect to the first: the form of the body of these medusæ may be compared to the umbella of a fungus, convex on the

upper part, and concave in the under, the diameter of which may be two, three, or four inches, according to the ſize of the animal. And as the umbella in many fungi becomes thinner towards the edges, the ſame is obſervable in the umbella of theſe animals (for by this name I ſhall continue to call it), which likewiſe is cut at the edges into a kind of fine fringe. Where the concavity of the umbella in the fungi is attached to the central ſtalk, we find adherent, in that of the meduſæ, towards the middle, four long cylindrical bodies, which, with the ſyſtematic naturaliſts, I ſhall call tentacula, or feelers; beſides eight other lateral ones, which are much thinner, and adhere longitudinally to the internal ſides of the umbella. But this general deſcription requires a more circumſtantial detail.

The umbella of each of theſe meduſæ in the external parts is ſlightly convex, and here the ſurface is extremely ſmooth, and covered with a humid ſlime, even when the animal is out of the water. It is thickeſt

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in the higheſt parts, and becomes gradually thinner in the lower. In the higheſt part of its cavity is an aperture which opens into a kind of gelatinous purſe, communicating with four lateral orifices. By theſe the ſea-water enters, and iſſues again by the aperture; and that which again has entered the aperture paſſes through the purſe, and goes out at the four orifices. I ſuſpect this aperture to be the mouth of the animal, and that the purſe acts the part of a ſtomach, at leaſt a receptacle, in which the food is digeſted; though I never diſcovered any within it, but always found it appear to be empty.

The ſubſtance of the umbella is ſo tender and delicate that it may eaſily be cut with a thread; it has alſo ſuch tranſparency, that it is equal, in that reſpect, to the pureſt cryſtal. In the greater part of it, neither the anatomical knife, nor the eye aſſiſted with the lens, can diſcover either veſſels, fibres, or other diſſimilar parts, which are found in almoſt all animals. It preſents the appear-

ance of a perfectly ſimple homogeneous jelly; only, at the top of the cavity, we diſcover four ſmall groups of long thin bodies, entwined together, and formed like inteſtines, adhering to an entangled maſs of ſmall, extremely tranſparent tubes, of a ſilver colour, and with ſides ſufficiently elaſtic to preſerve their round figure when cut tranſverſely. From the repeated examinations I made of them, I was convinced that they do not convey any kind of liquor. The great analogy they have to the tracheæ of inſects might induce us to ſuppoſe that theſe tubes are intended for the ſame uſe. At any rate it cannot be improper to call them tracheæ-form tubes.

In the ſame manner as in the higheſt part of the cavity of the umbella we diſcover the ſmall organized bodies above deſcribed, we likewiſe obſerve, at the internal edges of the ſame, another organized ſtructure, conſiſting of a very thin muſcular membrane, which riſes from the bottom about half an inch or a whole one, according to the

the ſize of the meduſa. Where this membrane exiſts, the great tranſparency of the umbella is ſomewhat obſcured.

We will now proceed to ſpeak of the tentacula:—and firſt of the largeſt, which we have ſaid to be four in number. Theſe in their lower part grow out of the edges of the umbella, and by their higher are attached to the upper parts of its cavity, including in the middle the aperture which we have conjectured to be the mouth of the animal. Each of theſe has a ſlight longitudinal furrow, terminated by two membranous appendages, moiſtened by a viſcous humour. On examining them internally, they are found to be compoſed of ſmall muſcular fibres, cloſely entwined, and extended lengthwiſe. In the middle of them there is a channel running their whole length. They are ſufficiently tranſparent for this to be viſible. It contains a number of globular molecules, which, by a preſſure of the finger on the tentacula, may be put in motion; and they may be made to iſſue

from the lower part of the tentacular, or from any other point, by cutting the latter tranſverſely.

The eight other lateral tentacula are much thinner, but longer. They have the ſame muſcular appearance, and are perforated in the middle through their whole length.

The tentacula, therefore, both large and ſmall, may be conſidered as veſſels or channels, though, as we ſhall ſee preſently, they are likewiſe deſtined to other uſes. I muſt obſerve, however, that no circulation or motion of the fluids of theſe meduſæ has been diſcovered by the moſt careful and minute examination, with the beſt microſcopes. The body and the tentacula of theſe animals are of a tranſparent light blue, without any mixture of other colours, with which ſome other ſpecies are pleaſingly variegated.

On taking one of theſe meduſæ in my hand, it did not ſuddenly diſſolve, as others have been deſcribed to do. It remained at

firſt

firſt entire, even when rubbed between the fingers, which, on preſſing it, felt a moderate reſiſtance. After ſome minutes it began to give out water, which it continued afterwards. This effect was not produced either by the warmth of the hand or the preſſure; at leaſt the latter only accelerated it. When the meduſa is laid on a table, or any other body, a moiſture begins to drop from it, and continues to do ſo, till the whole is changed into an extremely tranſparent liquid. Some of theſe meduſæ weighed fifty ounces; and the liquor into which they are gradually reduced being carefully collected in a veſſel, was found to want in weight very little of thoſe fifty ounces. The ſmall difference may probably be occaſioned by the part of the liquor which evaporates during the diſſolution of the meduſa. What remains is only ſome thin dry pellicles of the weight of about five or ſix grains. This liquor, when taſted, has the ſaltneſs of ſea-water, and when evaporated to dryneſs leaves in the veſſel a quantity of muriate of ſoda (ſea-ſalt), ſomewhat

what leſs than an equal quantity of ſea water would furniſh. This ſalt taſte is equally perceivable on touching the meduſa with the tongue, either during its actual diſſolving, or when it is firſt taken out of the ſea and waſhed in freſh water; provided, in the latter caſe, it be touched in a part where it has been cut. It is therefore evident, that the ſea-water, penetrating the organic texture, conſtitutes the greater part of the volume of theſe animals. This property is, in my opinion, extremely ſingular; at leaſt, among the various marine molluſca that I have examined, I do not recollect to have met with one of a ſimilar kind.

I muſt likewiſe obſerve, that this diſſolution of the body of the meduſa not only takes place when it is kept out of the water, but even while it continues in ſea-water contained in veſſels, if theſe are too narrow, and the water not frequently renewed. The cauſe in both caſes is the ſame; and is, no doubt, the injury and fracture of the ſolid parts, occaſioned by the removal of the me-

duſa

duſa from its natural ſtate; in conſequence of which, the liquids, being no longer confined within the body, gradually ooze out. It is, therefore, ſufficiently evident that, notwithſtanding we can diſcover no appearance of organization in the greater part of the body of the meduſa, we cannot deny that it exiſts; at leaſt we are forced to admit a delicate ſpongy and bibacious ſubſtance, which attracts and retains within it the ſea-water, though from its tranſparency, and, perhaps, likewiſe from the extreme fineneſs of its texture, it is not viſible.

Having thus ſufficiently examined the form and ſtructure of our meduſæ, we will now proceed, as was propoſed, to deſcribe their natural motions; which may be conſidered as the principal attribute that characterizes them as real animals.

Theſe motions do not differ from thoſe of the meduſæ which are not phoſphoreſcent, and conſiſt in an almoſt continual conſtriction and dilatation of the umbella. When, from

from a boat, we attentively obſerve a ſwimming meduſa, while the ſea is calm, we perceive that it turns the convex part of the umbella in an oblique direction to the ſurface of the water, and that the edges occupy the place behind. Theſe, every five or ſix ſeconds, ſuddenly contract, and a moment after enlarge. The meduſa, which is always immerſed in the water, and, conſequently, has the cavity of the umbella conſtantly full of it, at every contraction, or ſyſtole, preſſes out the included water, forcing it againſt the internal parts of the umbella, by which impulſe the meduſa proceeds one ſtep. Soon after it cauſes another ſyſtole, by which, receiving a new impulſe from the water, it again moves forwards; and this ſyſtole being inceſſantly repeated, and followed a moment after by the dilatation, or diaſtole, the animal has a ſlow progreſſive motion through the ſea. At the ſame time the tentacula ſtretch out from the edges of the umbella, extended, and grouped together. This reciprocal motion, which hereafter, for the ſake of brevity, I ſhall call

oſcillation, is neceſſary to enable the meduſa to ſwim, and remove from place to place; otherwiſe it would ſink to the bottom, as it is ſpecifically heavier than the ſea-water.

This latter fact I was certified of, not only by the experiments I made in the Strait of Meſſina, but by attentively obſerving ſeveral meduſæ in veſſels filled with ſea-water. In theſe likewiſe I could perceive ſeveral circumſtances relative to the oſcillation, which it was impoſſible to diſcover while they remained in their native habitation. I could, for example, aſcertain how much the periphery of the umbella, which approached to that of a circle, contracted at every ſyſtole; and perceived that the contraction was about two, three, or, at moſt, four lines. I ſaw that the oſcillation reſided only in the umbella, and that it was entirely independent of the purſe and the large and ſmall tentacula: ſince if all theſe parts are cut away, the oſcillation will continue exactly the ſame. I perceived likewiſe, that though this motion extends through the whole

whole of the umbella, a great part of it only moves by a conſentaneous vibration.

This the following experiments evidently proved. I raiſed a circular piece of the umbella, an inch in diameter, towards the upper parts, cutting it tranſverſely and parallel to the edges. This piece no longer oſcillated, and was inſenſible to any ſtimulus; though the oſcillation ſtill continued for a long time in the remainder of the umbella. This remainder I diminiſhed ſtill more, by cutting, tranſverſely, another circular portion from the umbella; which portion likewiſe no longer manifeſted the leaſt ſign of oſcillation. By repeated ſections of this kind, I, at length, diſcovered the ſeat and origin of the oſcillation in theſe meduſæ. I have already mentioned a fine muſcular membrane which extends from the edges of the umbella a certain ſpace, and ſtretches over its inner ſides. This, when viewed with the lens, is found to be compoſed of an immenſe number of carnous tranſverſal fibres, parallel to each other, and cloſely adhering

hering to the gelatinous ſubſtance of the umbella. On the action of theſe tranſverſal fibres, and their relaxation, depends the whole play of the oſcillation. As often as they are ſhortened, the portion of the umbella to which they are attached is forced to contract; in conſequence of which the ſame contraction extends to the remainder of the umbella. This produces the ſyſtole of the meduſa; from which we eaſily underſtand the nature of the diaſtole, which reſults from the relaxation of the ſame fibres. So long, therefore, as we take from the umbella a part in which there are none of theſe muſcular fibrillæ, it will, when detached, have no oſcillation; but this is not the caſe when it is united to a portion of them, as I have ſatisfied myſelf by obſervation and experiment. When a circular piece of the meduſa, which contained no carnous fibres, was cut out of the meduſa, and, for the greater convenience and preciſion in the experiment, laid on a dry table, it did not oſcillate; but it had this motion, and it continued for a long interval if it was ſurrounded

rounded by theſe fibres; and, when the ring which contained theſe fibres, and which, in the larger meduſæ, is about the breadth of an inch, was laid alone on the table, it was curious to ſee in what manner it became conſiderably narrower at every ſyſtole.

Theſe experiments led to others, which I ſhall here deſcribe. I cut, tranſverſely, the ring which contains the muſcular fibres into ſeveral pieces. Each of theſe pieces oſcillated; and, in them, the play of the fibres in action was viſible in an extraordinary manner. From time to time they ſuddenly became ſhorter, and then the piece which contained them became likewiſe ſhorter and thicker: a moment after, they returned to their former length, and the containing piece became thinner and longer. The motions of the cut pieces reſembled thoſe of a worm, which, as it glides along, firſt lengthens and renders thin its body, and, afterward, ſhortens and thickens it.

I de-

I detached, with a very ſmall pair of pincers, the muſcular membrane from a portion of the ring; when the oſcillation immediately ceaſed; as it likewiſe did if the fibres were only cut in ſeveral places.

From theſe experiments I naturally concluded: Firſt, that the ſeat of the oſcillation is placed in the above-deſcribed muſcular membrane: Secondly, that the gelatinous part of the umbella oſcillates from the immediate communication it has in the lower parts with this membrane: Thirdly, that the oſcillation does not ceaſe though the meduſæ be transferred from their native element to the land. During twenty-four hours, ſome of the largeſt meduſæ, being laid in a dry place, did not ceaſe to oſcillate, notwithſtanding they had diſſolved till they ſcarcely retained one third of their ſubſtance. Towards the expiration of this time, indeed, the oſcillation became feeble, ſlow, and interrupted. But, when it appeared to have entirely ceaſed, it might frequently be renewed by friction, or punctures made in

the muſcular membrane of the umbella. Even when the gelatinous ring to which this membrane is cloſely attached was taken out of the meduſa and cut in pieces, every piece, by theſe means, might be made to reſume, for ſome time, its oſcillation; which, in ſhort, only ceaſed when the group of tranſverſe fibres was either dried up for want of moiſture, or corrupted and deſtroyed from exceſs of it.

This pertinacious continuation of motion in the meduſæ, when dying and ſevered in pieces, may be thought an inconteſtable proof that this motion is independent of the will of the animal, like the pulſation of the heart of a frog, tortoiſe, or ſerpent, when taken out of the thorax of thoſe creatures. I will not, however, venture abſolutely to affirm this. I have frequently obſerved the ſwimming meduſæ in the ſhallows of the Strait of Meſſina. Some of them, after having, by their oſcillation, ſuſtained themſelves for ſome time at the ſurface of the water, ceaſed to oſcillate, and gradually

gradually ſank to the bottom by their own weight. There they remained motionleſs for a quarter of an hour, half an hour, or more; when, reſuming their oſcillation, they began, by degrees, to aſcend, and roſe to the ſurface of the water. Other meduſæ, if the depth of the water were, for example, four feet, would ſink in it two; and then, their oſcillation recommencing, return to the ſurface. Does not therefore the ceſſation of this motion, and its renewal, in theſe circumſtances, appear to depend on the will of the animal? I leave it to the enlightened reader to form his own judgment, contenting myſelf with a ſimple and faithful narration of facts.

I cannot omit to mention a motion of another kind which is obſervable in the long and ſhort tentacula, and in the long and thin parts formed like inteſtines. With reſpect to the former, the motion in them may be better obſerved when they are detached from the meduſa than when they make a part of it. If therefore they are ſeparated

from the cavity of the umbella to which they are faſtened, and laid in the palm of the hand, a ſlight motion is perceivable in them, which becomes much more ſenſible in their membranous appendages, and continues in the latter when divided from the tentacula. This motion, however, ſoon ceaſes, though theſe parts ſhould have been ſeparated from the meduſæ that were moſt vigorous and full of life.

More durable, and likewiſe ſtronger, is the motion in the parts formed like inteſtines, which, as we have ſaid, compoſe, as it were, four ſmall ſkeins of fibres ſituated near the lateral orifices of the umbella. If theſe are left in the ſame ſituation, or taken out of the animal, and laid dry on a table, or in the ſea water, they preſent the ſame appearances as the inteſtines, for example, of a dog when taken out of the living body and obſerved. We know that the inteſtines for ſome time do not ceaſe to exhibit the periſtaltic motion, reſembling that of worms or ſmall waves undulating from ſide to ſide.

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We know likewiſe, that when all motion has ceaſed, it may be again, in ſome degree, excited, at leaſt for a certain time, by means of ſtimuli. Similar motions I diſcovered in the abovementioned parts, which, as I found them hollow within, and containing in their cavity an extremely liquid and delicate matter, I do not greatly heſitate to believe to be true inteſtines. The compoſition, beſides, of their coats, as alſo that of the tracheæform tubes, is of a different kind from that of the reſt of the body. At leaſt, when the latter is nearly conſumed by diſſolution, both theſe kinds of ſmall tubes ſtill remain entire; and in thoſe which are formed like inteſtines, the vermicular motion ſtill continues.

Having thus deſcribed the organization and motions of theſe meduſæ, it now remains to ſpeak of the ſingular property they poſſeſs in being phoſphoric, and which was the primary object of the preſent account.

If in the beginning of the night we enter the Strait of Meſſina in a low bark or boat,

coaſting near the land, where the water is perfectly calm, the meduſæ, which are uſually very numerous there, begin to ſhine with a light, which, as the darkneſs increaſes, acquires intenſity and extent; every meduſa reſembling a bright torch, that may be ſeen for ſome hundred paces round; and on approaching it, the brilliant phoſphorus ſhews the form of the body. This light, when the evening twilight is extinct, is of a lively white, which ſtrikes the eye even when the animal is five-and-thirty feet below the ſurface. As the meduſa, by its oſcillation, transfers itſelf from place to place, ſo the light is variable, and is ſtronger in the ſyſtole than in the diaſtole. Sometimes it continues for a quarter of an hour, half an hour, or more; but at other times it ſuddenly becomes extinguiſhed, and does not re-appear till after a conſiderable interval. This interruption of the light induced me to ſuſpect that it might depend on the oſcillation of the meduſa, which remaining for ſome time ſuſpended, might likewiſe ſuſpend the phoſphoreſcence. Thus we know the

little phoſphorus of the terreſtrial flying glow-worm is interrupted, being lighted up by every motion of the body, and extinguiſhed in the moments of reſt. A ſimilar alternation I likewiſe diſcovered in the marine glow-worm *(Nereis marina Lin.)*.

It was not, however, very practicable to make ſuch obſervations on the animal, while in the ſea, as ſhould aſcertain the truth or error of this conjecture. I therefore applied myſelf to examine the meduſæ in veſſels filled with ſea-water, in which they would remain alive ſeveral days if the water were frequently renewed and the veſſels were large *. In theſe the phoſphoreſcence being not in the leaſt inferior to that they poſſeſſed when in the ſea, I could diſtinctly perceive, that ſo long as the meduſæ uninterruptedly oſcillated the phoſphoreſcence continued, only that it was more vivid in the ſyſtole than in the diaſtole, as I had obſerved in the ſea.

* This experiment, and thoſe which follow, relative to the phoſphoreſcence of the meduſæ, were almoſt all made in the night, and in the dark.

But when the oſcillation ceaſed, either entirely or at intervals, the phoſphorus was ſo enfeebled that, to inattentive eyes, it would appear entirely extinct. Of this the following fact is a proof:

In the chamber in which I ſlept at Meſſina, I had kept, for ſeveral days, a number of meduſæ in buckets filled with ſea-water. In one of theſe, the water having been neglected to be changed, the meduſæ it contained had greatly ſuffered, and no longer oſcillated when I returned to them, which was in the evening, ſoon after ſunſet. The phoſphorus then no longer appeared, except when by handling the meduſæ they were made to oſcillate, for a ſhort time. During three ſucceſſive hours, in that night, I remained in the ſame chamber, ſitting at a table to note down the obſervations I had made in the courſe of the day; and in that time, having twice caſt my eyes on the bucket, I found it entirely dark, though the candle had been removed into another room. But riſing before day, and approaching the bucket, which

which ſtood in one corner of the chamber, in the dark, I perceived that the dying meduſæ ſtill emitted a pale, indeed, but very apparent light, which I diſcerned at ſome diſtance from the veſſel, and while it remained perfectly undiſturbed.

It was eaſy to repeat this experiment on other meduſæ, and ſuch a repetition was of importance. The reſult was exactly the ſame. I found likewiſe that the meduſæ did not entirely ceaſe to ſhine till they were dead and began to putrefy. I therefore concluded that the phoſphoreſcence of theſe animals cannot properly be ſaid to be interrupted; but that during the oſcillations it is ſtronger and more lively; though a feeble light ſtill continues in the intervals of reſt, ſo weak indeed that it cannot be diſcerned unleſs the eye be cleared of the impreſſions of light from ſurrounding objects, as was mine, when, after having ſlept in the dark room, I proceeded before day to make obſervations of this kind: a practice which, taught by experience, I found very advantageous

tageous in ſeveral other experiments on the phoſphoreſcence of theſe meduſæ, which I ſhall hereafter relate.

If the meduſæ, inſtead of being kept in their native water, are left in a dry place, the light continues very clearly diſcernible, as long as the oſcillation laſts, that is to ſay, for a ſhort time; but inſenſibly decreaſes in proportion to the diminution of that motion. The ſame is equally obſervable when they are kept in the veſſels. In this caſe, likewiſe, the feeble light in the intervals between the oſcillations is diſcoverable.

With reſpect to the meduſæ which were kept out of the water, a fact preſented itſelf to my obſervation, which, from its extraordinary nature, I ſhould have ſuppoſed accidental, had not the ſame reſult followed on repeated trials. A meduſa having been left two-and-twenty hours on a ſheet of white paper had ceaſed to live; the greater part of it was even diſſolved into a liquor, and every luminous trace was become extinct.

A large

A large glaſs full of well-water happening to ſtand on the table, I, without any particular intention, chanced to throw the meduſa into it, which directly ſank to the bottom, and remained there motionleſs; but, to my great ſurpriſe, immediately ſhone with ſo bright a light that I was able to read characters of a tolerable ſize. The water at the ſame time became very luminous, and on immerſing my finger in it, it was plainly diſcernible. Thinking that the ſame would happen, and perhaps with more effect, if ſea-water were uſed; I threw the well-water out of the glaſs, and filled it with ſea-water. But no light was now viſible. I ſubſtituted freſh water for ſalt, and a beautiful phoſphorus again appeared.

Analogous to this phenomenon, of which I am unable to aſſign the cauſe, was the following:

Another meduſa which was dead, and had not been luminous for ſome time, was lying, out of the water, in the window of my

my chamber during the night. A ſlight rain chanced to fall, and every drop which fell on the dead meduſa was changed into a brilliant ſpangle, till in a ſhort time the meduſa was ſtudded all over with ſuch ſhining points. I could produce no ſuch effect by ſprinkling it with ſea-water in imitation of rain.

Hitherto we have principally conſidered the light of the meduſa as it preſents itſelf naturally; we will now make ſome obſervations on it as it is excited by art. The motion of the parts of the meduſa not only will increaſe its light, but rekindle it when it is apparently extinct. When they are brought from the ſea to the veſſels, their phoſphoreſcence is extremely brilliant; and its intenſity eſpecially increaſes if they are taken between the fingers and ſhaken in the water, or when their body feels the preſſure of the hand. In like manner, when the light is enfeebled by long continuance in the veſſels, it may be re-invigorated by friction. The effect is the ſame when they are kept out of the

the water. When, therefore, all appearance of light has vaniſhed, it may be ſuddenly reſtored by the means above mentioned. Theſe augmentations and revivings of the phoſphoreſcence, however, are tranſient, and continue but little longer than while the friction or agitation is applied. The reappearance of the light, likewiſe, does not take place except when ſome entireneſs in the parts of the animal is preſerved; otherwiſe the action of the hand or any other body is to no purpoſe.

When the meduſa is handled or rubbed in the water, the quality of phoſphoreſcence paſſes into the latter; which it likewiſe does when the animal is left immerſed in it. But this experiment ſucceeds much better in freſh than in ſalt water; as I have obſerved that, other circumſtances being equal, the brilliancy of the former is nearly double that of the latter. We may, therefore, by means of theſe meduſæ, create artificial phoſphori.

For

For this purpoſe I employed well-water, as being more ſuitable, and with it made ſeveral experiments deſerving attention. In thirteen ounces of this water, contained in a cryſtal glaſs, I ſqueezed two large meduſæ, which had juſt been taken out of the ſea. The water became ſomewhat turbid, but at the ſame time ſo luminous, that it gave ſufficient light to a whole room. After two-and-twenty minutes it began to grow feeble, and at the end of an hour and a half was entirely extinguiſhed. Agitation, however, then reſtored it, in the ſame manner as we have ſaid it revived the phoſphoreſcence of the meduſæ when it appeared to be extinct. If, therefore, the water in the glaſs was ſtirred with a ſtick, or even with the finger, the brightneſs re-appeared, but was always feebler in proportion to the time elapſed. I obſerved, likewiſe, that the greater the agitation of the water, the brighter was the phoſphoreſcence, which, however, when the water was no longer agitated, had only a momentary duration, as we have before remarked of the meduſæ.

When

When the water can no longer be excited to phoſphoreſcence by the motion of its parts, it may by the application of warmth. I made the experiments I have related, in a temperature of between 21 and 24 degrees of Reaumur's thermometer (80° and 86° of Fahrenheit); and if in this temperature the water in the glaſſes, though ſtrongly ſhaken, emitted no light, it became lucid when the thermometer roſe to 30° (100° of Fahr.) and ſtill more vivid in a higher temperature, provided it was not too high, for then it entirely ceaſed.

I made this experiment with other liquors beſides water, and found ſeveral, which I had imagined unſuitable for ſuch a purpoſe, might be impregnated with the light of the meduſa. Such, for example, was human urine, which, in the intenſity and duration of its phoſphoreſcence, was not inferior to freſh water. But the experiment ſucceeded better in no fluid than cow's milk. A ſingle meduſa, of a moderate ſize, being preſſed and ſhaken in twenty-ſeven ounces of this mik, rendered

rendered it ſo luminous that I could read the writing of a letter at three feet diſtance. The duration of this phoſphorus was likewiſe greater than that of the water. After eleven hours from the time I firſt put the meduſa into it, it ſtill retained ſome light; and when that ceaſed, agitation reſtored it, as did warmth, when agitation alone became ineffectual.

Repeating the experiment with the ſame milk, I poured it out of the glaſs upon the floor of the room, in order to obſerve the appearance it might produce. While in the air, it exhibited a kind of very white and ſhining cataract, and, when it reached the ground, formed a little lake of light, at firſt vivid, but which, in a few moments, grew feebler, and, in about five minutes, entirely diſappeared.

If the hand were immerſed in the phoſphoreſcent milk, and drawn out again, it appeared elegantly ſilvered over; but this colour ſoon vaniſhed; though it might be made

made to return for a moment by rubbing or warming the hand. This light not only attached to the hand, but to cloths; as I perceived in a towel, one edge of which had touched the luminous milk. In this caſe, likewiſe, the re-appearance of the light might be obtained by rubbing or warming the cloths.

While employed in theſe experiments, I obſerved that throwing the milk againſt any hard body would reſtore its phoſphoreſcence when extinct. The ſame milk, which emitted no light on the ſtrongeſt agitation within the veſſel, when let fall upon the floor became luminous; and the more violent the blow, the brighter was the light. Thus, if by night this liquor was poured from a high window, while it was in the air it had no luminous appearance, but, as ſoon as it ſtruck the ground, ſhone with a bright light; which, however, preſently grew feeble, and diſappeared.

Theſe appearances, it is to be obſerved,

were not confined to milk exclusively of all other liquors: they were likewise exhibited by fresh water; but the vividness and duration of the phosphorus were greater in the milk than in any other fluid with which I made the experiment.

A question which I considered as of importance, and endeavoured to resolve with every possible attention, presented itself in the course of these enquiries—Does the phosphorus extend over the whole body of the medusa, or only reside in certain parts? It was impossible to attain the solution of this problem by observing the animal when swimming in the sea. Besides that the tentacula, from their situation, are then, in part, covered by the umbella; the spontaneous agitation of the medusa, and that which the sea usually has, only allowed me to discern a globe of light. I could therefore only prosecute my enquiry on this subject by examining the medusæ, kept in sea-water, in vessels which I procured of glass that I might be able to see the whole body of the animal

animal while it ſhone in the dark. But at firſt I did not obtain that ſatisfactory elucidation which I ſought.

A meduſa taken freſh out of the ſea, and placed, full of life and vigorouſly oſcillating, in a veſſel filled with freſh ſea-water, appeared luminous in every part; only that the light was more vivid in the large tentacula, and at the edges of the umbella. I was doubtful, however, whether the feebler brightneſs of the other parts was derived from thoſe more reſplendent, or whether they had a weaker light of their own. I waited till the oſcillation had ceaſed by the approaching death of the animal. We have already ſaid that even then ſome light is diſcernible, provided our eyes be cleared from the light of all ſurrounding objects. My doubts now began to be elucidated.

When all motion had entirely ceaſed in the meduſa, the edges of the umbella ſhone feebly, while the other parts of it were quite dark, and the larger tentacula ſomewhat

more vividly than the edges. I ſuſpected, therefore, that the true ſeat of the phoſphorus was in theſe parts, and the facts I ſhall now proceed to relate ſatisfied me that I was not miſtaken. If the umbella of a meduſa, immediately after the animal is taken, be cut with a pair of ſharp ſciſſars, ſo that the edges are ſeparated from it in a ring of about five or ſix lines in breadth, and the finger be paſſed over this ring, a phoſphoreſcence will be manifeſt in every part that is touched. In like manner, if the ring be cut in pieces, every piece, on being touched, will become luminous, and continue ſo for ſome time. On the contrary, the remainder of the umbella, deprived of the tentacula and its other appurtenances, though containing incomparably more of the ſubſtance of the animal than the ring, remains totally dark, however it may be rubbed, preſſed, cut, or ſtimulated in any other manner.

It is to be obſerved, that all that part of the ring which is phoſphoreſcent is internally covered

covered with the muſcular membrane which we have before mentined. May not this, therefore, be the cauſe of the phoſphoreſcence, or at leaſt concur to produce it? I have diſcovered that it is not; ſince, if it be entirely taken away, the phoſphoreſcence continues as before: and I have alſo found that this light depends on a ſomewhat denſe and viſcid humour which moiſtens and covers the bottom of the umbella, and which will be preſently deſcribed more at length.

But there is no part of the animal which ſhines brighter than the largeſt tentacula. If theſe are taken, either ſeparately or united together, between the fore finger and the thumb, and the two fingers are paſſed over them from one end to the other, a line of very vivid light is produced which continues ſome ſeconds; and the experiment ſucceeds in the ſame manner when the tentacula are detached from the animal. It may be repeated eight, ten, or even twelve times with equal ſucceſs, except that the light continually becomes fainter. The reaſon is

very evident. Here, as at the edges of the umbella, the phoſphorus reſides in the denſe and viſcid humour; which, by repeated friction, is carried away by the fingers, to which it adheres; until at length the light entirely ceaſes. The ſame is true of the edges and the purſe attached to the internal upper part of the umbella; ſince that likewiſe, when touched, has ſome phoſphoreſcence, the ſurface of it being moiſtened by the viſcid humour. I made numerous and different experiments of theſe animals, but I could find no other parts of them which poſſeſſed this luminous quality but theſe three: that is to ſay, the large tentacula, in which it principally reſides; the edges of the umbella, which are next with reſpect to the vividneſs of their light; and the purſe communicating with that aperture of the umbella which is perhaps the mouth of the animal, and in which the light is feebleſt. Theſe phoſphoreſcences take place whether the animal be in or out of the ſea-water; but they are moſt vivid in the former caſe.

That

That this humour, as far as can be diſcovered by our eyes, is the cauſe of the light in theſe meduſæ, is ſtill more confirmed by the following facts: If either of the three parts above mentioned, but eſpecially the larger tentacula, be rubbed between the fingers in the night-time, a portion of this humour will adhere to them, and the fingers become vividly phoſphoreſcent. If the roots of the tentacula be graſped in the hand, and it be drawn along to the ends of them, the whole palm will become luminous, and at the ſame time clammy. If the ſame action be repeated, the ſame light will reappear, as long as any portion of the viſcous matter ſhall remain; but, when that is entirely exhauſted, the phoſphoreſcence will ceaſe. When I handled the remainder of the body of theſe animals, I found no viſcid matter adhere to my fingers, nor was any luminous appearance produced. If this humour be ſcraped off with a knife, and put into a a glaſs filled with water or milk, and ſtirred with the finger or a ſpatula, both thoſe fluids will become phoſphoric;

which they will not when the moiſture expreſſed from any other part of the meduſa is mixed with them. It hence appears, that when the body of the meduſa is ſqueezed in any liquor, it is not every portion of it which communicates the luminous quality, but thoſe parts only of which we have been ſpeaking; that is, the large tentacula, the purſe, and the edges of the umbella. It is neceſſary, alſo, to this phoſphoreſcence, that theſe ſhould be taken from a living meduſa, or one that has very recently ceaſed to live; otherwiſe, as they will be incapable of emitting light, they cannot communicate that property to other bodies.

We may here remark the great difference there is between theſe meduſæ, and many others which I have obſerved in other ſeas. The latter are not phoſphoreſcent either living or recently dead, but only when they corrupt and become fœtid: thoſe, on the contrary, of which we now treat, produce, as we have ſeen, effects entirely oppoſite.

From

From the obſervations and experiments contained in this chapter, it is ſufficiently evident that the liquor produced by the diſſolution of the meduſa is different from that which is phoſphoric; ſince the former extends itſelf through, and penetrates, the whole body of the meduſa, and the latter has its reſidence only in three particular parts. The following facts will briefly corroborate this proof: When the tenacious liquor is expreſſed from the larger tentacula, the phoſphoreſcence, as has been ſaid, entirely ceaſes; though another fluid ſtill continues to iſſue from them till their entire diſſolution. When theſe tentacula, alſo, are cut tranſverſely from a meduſa recently taken, and conſequently very luminous, the ſurface of the ſection is dark, though abundance of moiſture iſſues from it; and the light only appears on the ſurface which has not been cut, that is to ſay, where the phoſphoric moiſture reſides: they are therefore two different ſubſtances. It is true that, from want of the requiſite means, I was not able to analyſe them chemically; but the ſenſe

of

of tasting sufficiently discriminated them. The liquor into which the phosphoric meduſæ are resolved is, as we have seen, very salt; which saltness it derives from the muriate of soda with which it abounds. It is not surprising, therefore, that it is no otherwise disagreeable to the taste. But the phosphoric liquor has a very different effect, and is even painful to the delicate parts of the skin if it accidentally touches them. My curiosity twice induced me to taste it with the tip of my tongue. The sensation it excited was that of a burning smart, which lasted more than a day. A similar sensation, but much more painful, I experienced in my eye, from a drop of this liquor casually flying into it. Even the back of the hand felt a slight pain when long applied to this animal.

I must not omit to notice, that the excitement of this troublesome pruritus is not confined to this phosphoric liquor, since I have experienced the same sensation on touching meduſæ which were not phospho-

rescent

reſcent in the Gulph of Spezia, as I have remarked in an Eſſay publiſhed in the Memoirs of the *Italian Society*. We hence underſtand why Ariſtotle and Pliny called theſe molluſca *ſea-nettles*; though it is certain that ſome ſpecies of them are innocent; as thoſe which were examined by the illuſtrious Reaumur, on the coaſt of Poitou, and thoſe which I met with in the Strait of Conſtantinople and other places.

A few more remarks only remain to complete the hiſtory of theſe animals. I made the obſervations and experiments here deſcribed, in October. The Strait of Meſſina was then full of them, eſpecially in the vicinity of the Lazaretto, where the water was calm. The parts of the ſea which are the calmeſt are moſt frequented by them; at leaſt it is certain that, however ſtrongly the meduſæ oſcillate, they cannot reſiſt the agitated waves, but are driven to the ſhore by them, as I have ſeen in other parts of the ſame Strait. At Meſſina they are called *bromi*; and I was aſſured by the ſailors that they

they are found there in all ſeaſons. In my excurſions round the ſhores of the Eolian iſles, I only ſaw two in the night-time in the channel of Vulcano, which I diſcovered by their phoſphoreſcence, and found to be of the ſame ſpecies with thoſe now deſcribed. At Lipari they are well known, and called by the expreſſive name of ſea-candles *(candellieri di mare)*.

I once, in the ſame Strait, obſerved one which had a ſmall fiſh ſticking to its tentacula, being held by the viſcous liquor; and the fiſhermen aſſured me that this might be frequently ſeen. It ſeems probable, therefore, that theſe ſmall animals, and others ſimilar, are the food of the meduſæ, and that the tentacula are a kind of net in which they are taken by the aid of the viſcous liquor, though they are likewiſe deſtined for another uſe, as that of giving light. I find that this was the opinion of Pliny.

I have ſome ſuſpicion that theſe molluſca are hermaphrodites, or that every indivi-

dual

dual is capable of propagating its ſpecies without commerce with another, as is obſervable of many other marine animals of the claſs of vermes. This conjecture I do not merely found on my never having obſerved two coupled together, but on the ſameneſs of organization in all that I have examined, which were in number more than a hundred. The extreme tranſparency of their bodies afforded me an opportunity of obſerving their internal parts, and endeavouring to aſcertain whether they were produced by eggs or fœtuſes; but with reſpect to this I could arrive at no certainty. In ſome of the larger ſized, I could perceive, at a ſmall diſtance from the minute tracheæ-form tubes, numerous aggregates of globules, which I never diſcovered in the ſmaller meduſæ; and in others, more corpulent, I obſerved theſe globules ſtill larger; which induced me to ſurmiſe that theſe globules might be eggs. But the neceſſity I was under of leaving Meſſina, compelled me, much againſt my will, to deſiſt from my enquiries on this ſubject.

This

This new ſpecies of meduſa may be thus characterized—*Meduſa phoſphorea orbicularis convexiuſcula, margine fimbriato, ſubtus quinque cavitatibus, tentaculis quatuor craſſioribus centralibus, octo tenuioribus lateralibus longioribus.*

Having thus deſcribed one marine animal which emits light, I will conclude this chapter with mentioning another which is very ſmall, but extremely numerous—I mean the ſea-glow-worm.

Signor Vianelli di Chiozza is well known to have been the firſt naturaliſt who diſcovered one ſpecies of them. He ſhewed that the light which in the darkeſt nights illuminates the Venetian Laguna, eſpecially when the water is ſtruck by the gondola's oars, or any other body, proceeds from theſe minute animals, which are immenſely numerous in that lake.

A light of the ſame kind, proceeding from the ſame or a ſimilar animated princi-

ple,

ple, I have obſerved in the Mediterranean; that part of it, at leaſt, which waſhes the eaſtern coaſt of the territory of Genoa; where, beſides the marine glow-worm or ſhining nereis of Vianelli, I diſcovered five new ſpecies *.

In the ſea which ſurrounds the Eolian iſles I found no ſuch animal phoſphorus. In that of Sicily it was not wanting. In my voyage from Lipari to Meſſina and Catania, and on my return to Lipari, I was three times obliged to paſs the night on the water. The ſea was here ſhallow, and the bottom abounded with ſea-weeds. Theſe plants in the darkneſs of the night ſhone with ſudden and bright flaſhes, which became more numerous when I moved them with the end of an oar, and induced me to ſuppoſe they contained marine glow-worms. Having drawn up ſome tufts of them from the bottom, I found, in fact, theſe animals attached to them; and that they were the

* See the Memoirs of the Italian Society, t. ii. p. ii.

cauſe

cauſe of their luminous appearance. That I might examine them more accurately, I carried them with me to Meſſina and Lipari, in veſſels of ſea-water; where, in a dark room, I detached the glow-worms from the ſea-weed, either by taking them off gently with my finger, as their light ſhewed me the preciſe ſpot where they were; or by ſhaking the leaves of the plant in the water, firſt placing a cloth at the bottom of the veſſel, upon which they fell, as they were ſpecifically heavier than the ſea-water. The cloth then appeared ſtudded with lucid points, which were the glow-worms I wiſhed to detach. Examining them with the lens, I found they were of two ſpecies. But as they do not differ from thoſe of the Gulph of Genoa, I ſhall reſerve the deſcription of them for the account I purpoſe to publiſh of my voyage to Conſtantinople, to which I ſhall add the obſervations I made in the Mediterranean and the Adriatic. It is evident, however, that the Laguna of Venice is not the only place in which theſe phoſphoric animals are found;

ſince they are met with, likewiſe, in the ſea of Genoa, that of Sicily, and, as will appear in the work above mentioned, in the Archipelago, the Sea of Marmora, the Strait of Conſtantinople, and the Black Sea.

CHAP. XXVIII.

OTHER MOLLUSCA DISCOVERED IN THE SAME STRAIT.

I. *Description of a new species of ascidia—The sea-water enters its body by two apertures, a superior and inferior—When pressed between the fingers, the water issues out in two spouting streams—This water insinuates itself into the internal part of the animal, without producing that small vertiginous current which the author observed in several other marine animals—Evident communication of one aperture with the other—The superior aperture seems to be the mouth of the animal, and the inferior the anus—No other motion observable in this marine worm but the opening and shutting of the two apertures—Usual size and colour of the larger ascidiæ—Several minute animals sometimes found adhering*

to

to them—Their coriaceous skin like a sheath which defends the tender body of the animal —When deprived of this skin, the animal still continues to draw in water through the apertures as before—Small longitudinal and transverſal muſcles, deſigned to produce ſome minute motions, though not apparent while the coriaceous ſkin inveſts the animal —Channel in the ſhape of a pear, which communicates with the lower aperture— Semitranſparent veſicles included in this channel, containing a central globule— Small aſcidiæ frequently attached to the larger without any internal communication between them—A viſcous liquor the cauſe of their adheſion — The generation of this ſpecies of aſcidia different from that of the polypi of Trembley — Conjecture that the globules contained in the veſicles are the eggs or rudiments of this animal— Characters which ſhew it to be ſpecifically different from the tethyum *of Bohadſch— Definition of this aſcidia*—II. *Singular tentaculated animal frequently found adherent to coral when fiſhed up in the Strait of*

Meſſina—Its deſcription—Species of ſyſtole and diaſtole in the longitudinal ſtreak of the back—Freſh water a powerful poiſon to it—Uncertain to what genus of molluſca it belongs—III. *A branching eſchara, which ſeems not to have been hitherto deſcribed, vegetating on corals and other productions of that part of the ſea—Its manner of growing, and its polypi—Small vertiginous current which the latter produce in the water, by which the minute particles proper for their food are conveyed to the mouth of the polypi—This current occaſioned by the motion of their arms—In what manner the polypi retire at pleaſure, and remain flat at the bottom of their cells—Their adheſion to the bottom of them—Polypi which have ceaſed to live in the old cells ſucceeded by thoſe produced in the new—Probable that the new cells and the new polypi are the development of ſome germ of an old polypus—This eſchara characterized*—IV. *Another ſpecies of polypus found in the channel of Meſſina, in which the circulation of the fluids is viſible—Detailed*

deſcription

deſcription of theſe polypi and this circulation—Anomalies in the latter produced by various circumſtances—In what temperature theſe polypi will continue to live when out of the ſea, and in what they die—No appearance of an active principle in them productive of the circulation of their juices—Conſidered in itſelf, this circulation is as complete and perfect as it is obſerved in animals that rank much higher in the ſcale of animality—Definition of this polypus, which has been hitherto undeſcribed—

V. *Obſervations on the motions of ſome echini ſpatagi (ſea-urchins) found at the bottom of the Strait of Meſſina—They move from place to place, and fix themſelves at pleaſure by means of their tentacula, notwithſtanding the agitation of the ſea-water—Singular manner in which the tentacula act to produce this motion—The ſpines do not concur in producing this motion—Weight required to overcome the force of the tentacula which hold an echinus ſpatagus to the vertical ſides of a glaſs veſſel—A glutinous matter which every tentaculum emits,*

the cauſe of this ſtrong adheſion—Artifice which the echinus ſeems to uſe to free itſelf eaſily from its faſtening—The tentacula always remain within the body when the animal is out of the water—Little or no progreſſive motion then obſervable in them from the agitation of the ſpines.

IF the ſurface of the Strait of Meſſina preſented me with an intereſting object in the phoſphoreſcent meduſæ, its bottom afforded me equal pleaſure and inſtruction in the diſcoveries I made of other new and curious animals. Theſe were brought up in the nets which detach the coral from the ſub-aqueous rocks; a fiſhery of which I ſhall preſently treat more at length.

I. The firſt which I ſhall deſcribe is a ſpecies of the aſcidia, hitherto not noticed, to my knowledge, by any author. The genus is thus defined by Linnæus—*Corpus fixum, teretiuſculum, vaginans. Aperturæ binæ ad ſummitatem; altera humiliore.*

Its

Its form and natural dimenſions are repreſented in Plate X. Fig. I; with two ſmall aſcidiæ attached to the larger. This aſcidia is never found erratic in the ſea; but always with the hinder extremity rooted, either immediately to the rocks, or to ſome ſtone or other hard body (Fig. ead. G). The upper extremity branches out in two obtuſe projecting beaks; the one thicker and higher, and the other thinner and lower; both of which have in the middle an aperture, R. S. which is ſhut when the animal is taken out of the water, but gradually opens and remains open, as it appears in Fig. II. M. N. as often as it is ſuddenly put into a veſſel of ſea-water, if we wait till all agitation in it has ceaſed. The upper aperture then appears much larger than the lower, the former having the figure of a ſtar with eight rays, and the latter that of a leſſer ſtar with ſeven rays. When the veſſel containing it is ſhaken, the aſcidia cloſes the two apertures, but quicker than it opened them; and it is obſervable that they both cloſe or open at the ſame time.

There are ſome marine molluſca, as certain ſpecies of the holothuria, which, on being only taken into the hand, ſpout out the water they had imbibed in a ſtream. The preſent aſcidia receives it by two apertures, and, in a certain manner, is ſaturated with it; but it does not eject it when it is gently handled. To cauſe this ejection it muſt be preſſed between the fingers; when it ſpirts out the water, forming two thin jets or ſtreams in the air. It may in this manner be emptied, in which caſe it ſhrivels and dries up. But on being put again into the water, it re-opens the cloſed apertures, again fills itſelf, and becomes round as before.

In my various excurſions on the ſea, I have obſerved that it contains many animals which, abſorbing the water by their mouth, produce a ſmall vertiginous current, that runs into it. The animal in queſtion has not this power. The water enters it almoſt inſenſibly by occupying gradually the internal ſpace which was empty. This I perceived

ceived by making uſe of the lens, but more diſtinctly by tingeing the ſea-water with cochineal, as the animal will live ſeveral hours in this water without any apparent injury. The red particles of the tincture will then be ſeen ſlowly to enter the two apertures with the water, gradually filling the vacuity of the animal, without the appearance of a current of any kind. After ſome time the ſlow motion of the particles ceaſes; that is, when the internal cavity is completely filled with the coloured water, which I could cauſe to iſſue from the apertures at pleaſure, by preſſing the aſcidia between my fingers.

If, when all the water is thus brought out of the aſcidia, the animal be immerſed in that contained in a veſſel, in ſuch a manner that only one of the apertures be under water, it will fill itſelf completely by that, whether it be the upper or the lower. It is evident from this, that there is a communication between the two apertures; of which I alſo had another proof equally demonſtrative,

monſtrative, in the air which iſſued from the leſſer aperture, and which, by means of a ſmall tube, I could, without force, cauſe to paſs into the greater, and *vice verſa*. When, beſides, I kept one of the apertures cloſed while I blew into the other, the animal ſwelled like a bag, and the air found no vent.

It appears therefore certain, that the upper aperture is the mouth of the animal, and the lower the anus. In fact, by the latter I have frequently ſeen the aſcidiæ diſcharge matters which had all the appearance of being excrementitious. This lower oriſice, likewiſe, communicates with another channel, or organ, as we ſhall ſee preſently.

Except ſlowly cloſing and opening theſe two apertures, this ſpecies of aſcidia ſeems to have no kind of motion; not even when irritated by punctures, cutting, or any other violence.

The largeſt are more than two inches in length,

length, and above one in breadth. Their ſize is different according to their age, ſo that ſome very young ones are not more than two lines in length. They are all of a ſemi-tranſparent cinereous azure colour, ſomewhat reſembling that of the common calcedony. The ſkin externally is rather ſmooth, but ſoon becomes rough from the numerous ſmall ſea-ſnails which faſten to the back and ſides; a ſingle aſcidia frequently carrying on it a great number of other animals.

If this ſkin be cut longitudinally without injury to the internal part of the animal, it will be found reſiſting and coriaceous; and appear to be only a caſe which ſheaths and defends the tender body of the aſcidia. It is eaſy to detach it from the back, without lacerating it; ſince, except in the parts near the two apertures, where it adheres rather cloſely, it is almoſt looſe.

In Fig. III. this coriaceous ſkin, cut longitudinally, is repreſented entire, and ſtanding

ing upright, from its firmneſs and elaſticity. Fig. IV. exhibits the animal deprived of this ſkin, in which appear the two obtuſe beaks, and the two radiated apertures.

The animal, when thus naked, is tender, and almoſt gelatinous; but, which may excite ſurpriſe, even in this ſtate it does not deſiſt, when under water, from opening the apertures and filling itſelf with that fluid, when it is empty. Its colour is a delicate white, but, near the larger aperture, ſprinkled with red ſpots. On holding it up to the light, we perceive two ſeries of innumerable threads, the one running lengthwiſe, the other tranſverſely; which threads may be rendered very viſible, either by putting the animal into brandy, or by inflating it, and cauſing it to ſwell beyond its natural dimenſions. (Fig. V.)

On examining theſe threads, I diſcovered that they were ſo many minute muſcles, which, interſecting each other, formed quadrangular ſpaces in the middle; and were

deſigned by Nature, the longitudinal to ſhorten by their action the length of the body, and the tranſverſal to contract the breadth. In fact this double motion, though ſmall, is viſible in the denudated aſcidia; though it is not diſcernible when the animal is clothed in its coriaceous integument. Around the two apertures the threads or muſcles have a circular direction to cloſe them at the will of the animal. This is repreſented in Fig. V. In it likewiſe are expreſſed a number of black lines in directions entirely irregular, and which interſect, and form anaſtomoſes in ſeveral points, ſuch as we ſometimes ſee in the branches of the *Iſis nobilis* (the red coral). Theſe repreſent ſmall bands or fibres which interſect the two rows of muſcles, and the uſe of which I have not been able to diſcover.

If the animal, when deprived of the coriaceous ſkin, be rendered ſhrivelled and lax by its water being exhauſted, and then gently inflated with air; there will be diſcovered in its internal part a canal, ſhaped

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at the bottom like a pear, and correſponding to the lower part of the aſcidia. This canal, as it aſcends, becomes ſmaller, and, after having made two deflections, ends in the lower aperture. (Fig. VI. F. G. H.)

If this canal be lightly preſſed at the baſe, or in the middle, there iſſues from the lower aperture, which is its orifice, a kind of granulated matter, which, viewed with the microſcope, appears to be an aggregate of ſemitranſparent veſicles, each including a central globule of a yellowiſh colour. Both the veſicles and globules are of ſo delicate a conſtruction that they are diſſolved and deſtroyed by the ſlighteſt touch (Fig. VII.) Except this canal, another which forms a communication between the two apertures, and which may be ſeen on opening the animal, and that double ſeries of muſcles enveloped in part by the irregular bands or fibres; all the reſt of the animal appears ſo mucous and ſimilar, that I was unable to diſcover any other viſcus or characterized part of organization.

But

But what opinion ſhall we form of the globules contained in thoſe tranſparent veſicles? That they are poſſibly eggs or ſmall fœtuſes of this ſpecies of aſcidia? Before I proceed to explain what I think, or rather what I conjecture, relative to them, we will turn our attention, for a moment, to the ſmall aſcidiæ which are frequently found adhering to the large ones. In Fig. I. and II. the references B. C. point out two of theſe ſmall ones adhering to the larger aſcidia, in the manner mentioned at the beginning of the chapter. The ſecond (C) is attached to it entirely; the firſt (B) adheres in part to the marine concretion in which the mother-aſcidia is planted. Both the ſmall ones perfectly reſemble the adult aſcidiæ, not only in their apertures, but in the reſt of the body, and the internal parts; containing even veſicles and globules, though ſmaller in proportion. There are alſo many as ſmall as theſe, and indeed ſmaller, which are entirely ſolitary, and affixed to the ſub-aqueous rocks. But I rather choſe to confine my obſervations to thoſe aſcidiæ which

grow and develop themſelves on the larger, in order to diſcover what connection the former have with the latter. I ſoon perceived that they have no internal communication, but that all their connection is in the coriaceous ſkin. This is evidently ſeen in Fig. III. repreſenting the ſkin detached from the animal, with the ſmaller aſcidiæ adhering to it as before, without the leaſt injury or alteration. I found, likewiſe, that they might be ſeparated from the larger aſcidiæ, without hurting the coriaceous ſkin; and it is evident that they are only faſtened, and as it were glued by a kind of viſcous juice which always moiſtens theſe aſcidiæ in their early age, and by means of which, as was before remarked, other minute animals are frequently ſtuck to them.

Theſe obſervations prove that this ſpecies of aſcidia is not generated in the ſame manner with the polypi of Trembley (*Hydra viridis*, *fuſca*, *griſea*. *Linn.*) though at firſt view it might ſeem ſo to be from the ſmaller polypi pullulating on the larger. It

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is well known that the former are a continuation of the body of the latter; which is not the caſe in theſe aſcidiæ. I, however, incline to believe that theſe microſcopic globules, contained in veſicles, are the eggs or rudiments of the animal; and that, on their iſſuing from the canal above deſcribed, they remain attached to the body of the mother-aſcidia, where they develop and grow; and that they do the ſame on any other ſolid marine bodies on which they may chance to fall. This idea, however, I only offer as a conjecture, leaving to others who may be more fortunate in their enquiries to prove it true, or ſhew it to be an error.

On comparing this aſcidia with the various ſpecies of that genus already deſcribed, that which ſeems to have the greateſt reſemblance to it is the *Tethyum* of Bohadſch, which he has thus defined, "*Tethyum coriaceum, aſperum, coccineum, organorum orificiis ſetis exiguis munitis* *." It was placed

* De quibuſd. Animal. Marinis. Dreſdæ 1761.

by Linnæus in the genus of Aſcidiæ, with this definition—"*Aſcidia ſcabra tuberculis coccineis.*" But if this animal has ſome reſemblance to mine, it differs, at the ſame time, in ſeveral ſpecific characters. Omitting that the aſcidia of Bohadſch is always much larger, that it is of a ſcarlet colour, and that the thin ſkin which inveſts it is rough and ſcabrous; it is to be obſerved, that the upper aperture reſembles a croſs, that the lower is of a triangular figure, and that the edges of both are furniſhed with minute briſtles; all characters not found in that of which we treat.

It may be thus defined—*Aſcidia coriacea lævis ſubdiaphana, apertura ſuperiore octogona, humiliore heptagona.*

II. When coral is drawn up from the bottom of the ſea, and immediately thrown into its native water, reſerved in ſome veſſel, we frequently find on its branches an animal which, from its ſtrange and ſingular form, merits a moment's conſideration. It

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is delineated in Plate X. Fig. VIII, except only that it is repreſented ſomewhat larger than life, to render it more diſtinct to the eye. The head (M.) is enlarged on both ſides, and the mouth is placed in the under part of it. It has eleven lateral tentacula, five on the left, and ſix on the right ſide; nor muſt we imagine that the ſixth tentaculum is wanting on the left ſide; ſince out of thirteen individuals that I examined, I did not find one of a different conformation. The two anterior tentacula (H. I.) the animal can at pleaſure draw in, as ſnails do their antennæ, and conceal them in two hollow ſheaths X. Z. It can alſo puſh them forth at pleaſure. The other nine remain always in the ſame poſition, or that in which they are delineated, even when the animal moves. Seven of them are tridentated (O, R, T, V, L, Q, S,) and two quadridentated, (P. N.) The lower extremity of the animal terminates in a point (Y). When firſt taken out of the water the body is covered with a viſcoſity which attaches to the fingers, and forms ſmall threads like thoſe

cauſed by ſnails. The ſubſtance of the animal ſomewhat reſembles fleſh. It is of a cinereous yellowiſh colour. Along the back there is a ſtreak of a lighter colour, which has a regular motion of contraction and dilatation; and which I ſuſpect to be the heart, or ſome analogous organ, ſuch as that which is obſerved in the back of caterpillars and various other inſects. It does not ſwim, but crawls on the branches of coral, or other ſubaqueous body, after the manner of ſeveral other terreſtrial and aquatic worms. The part under the body, which we may therefore call the feet, has a great analogy with the ſame part in ſnails. Though not formed to ſwim, it can riſe to the ſurface of the water by inflating its body.

When taken out of the water it does not die very ſoon; but its death quickly follows when it is put into freſh water; as is the nature of many marine animals, to which, as I have repeatedly found, in many experiments, freſh water is a deadly poiſon, which even has the power, in ſome inſtances, of relaxing and deſtroy-

deſtroying their members in a few moments.

I am compelled to leave the hiſtory of this curious animal incomplete, ſince I had not time to make the obſervations on it that I could have wiſhed. But in what genus of the claſs of vermes ſhall we place it? The molluſca which ſeem to have the greateſt affinity with it are the limaces, and the dorides. But the characteriſtics of theſe two genera are not ſuitable to the preſent worm, as may be ſeen by conſulting Linnæus. Shall we then conſider it as conſtituting a new genus? I leave this queſtion to be decided by ſuch of my readers as are verſed in this part of natural ſcience; and proceed to deſcribe another kind of animals which are very numerous at the bottom of the Strait of Meſſina.

III. It is known that the eſcharæ are thin cruſts, having roots, and for the moſt part calcareous, formed of ſeveral rows of ſmall cells, at the bottom of which are implanted very minute polypi, furniſhed with filament-

ous arms. Theſe cells increaſe in number by new ones forming at their edges. Several authors, both ancient and modern, have written of theſe eſcharæ; and ſince Linnæus, this genus of lithophyta has been enlarged, with the addition of ſeveral new ſpecies, by M. Pallas; the greater part of which, however, have been deſcribed from the dead ſpecimens of muſeums, and not from the living eſcharæ of the ſea. Yet notwithſtanding theſe diſcoveries, ſo abundant are theſe marine productions, that it will not be difficult to find ſome that have all the characters of novelty. Such, I flatter myſelf, is that which grows on corals and other productions, both animate and inanimate, of that part of the ſea. At firſt it is a ſimple ſhoot, but afterwards multiplies and extends its branches, until it covers the bodies on which it has taken root. This eſchara is repreſented in Plate X. Fig. IX. nearly in its earlieſt ſtate, as ſeen through a microſcope, when it begins to put forth its firſt ſhoots on a branch of coral. It is formed of ſmall cells, ſomewhat flat and oval, membranoſo-calcareous, each of which has in the upper

upper part a round beak or mouth, with a longitudinal projection under it. I may ſay that this production was in part generated under my eyes, as I kept it in a ſmall veſſel full of ſea-water, which I was careful frequently to change.

At firſt there was only the ſmall trunk or ſtem A. D. formed of four cellules A, B, C, D, each containing its polypus. It afterwards grew upwards, and alſo ſhot out two lateral branches D O, E M. The polypi of the four lower cells died, and ſix others were produced; two at S, X, in the lengthened part of the trunk, and four, I, L, Z, V, in the two branches. I have obſerved in this eſchara, and in ſeveral others, that it appears to be a conſtant law of nature, that the older cells ſhall loſe their inhabitants, and the new ones acquire them; only that the latter have them not ſo ſoon, or at leaſt they are not ſo ſoon perceivable in them. Thus, at the time the ſix polypi above mentioned appeared, they were not perceivable in the four upper cells O, H, P, M.

This eſchara afterwards put forth other branches, which were followed by others, till it had produced a thick and crowded cluſter of them. I have not given the figure of this cluſter; that which I have given being, I doubt not, ſufficient to aſſiſt the imagination of the reader to form an idea of it. This eſchara is an extremely thin cruſt, and, being calcareous, the nitric acid, though diluted with water, diſſolves it almoſt in an inſtant, with a ſenſible effervescence.

But let us turn our attention to the polypi, which form the moſt intereſting part of this marine production.

If a piece of the eſchara be put into the hollow of a watch-glaſs, with ſome ſea-water, and viewed with a microſcope, taking care that the water be not ſhaken, the polypi will be ſeen to come out from their cellules, like minute cylinders, with their arms diſplayed at the top. Fig. IX. repreſents ſix of theſe polypi. The arms of every polypus are in number at leaſt twelve, and form a kind

a kind of inverted bell, which, by a continual agitation, produces a ſmall vertiginous motion in the water, that cauſes it to run to the narrow part of the bell, where is the mouth of the animal, which receives the water, and the particles ſwimming in it, from which it may chooſe thoſe proper for nouriſhment. A ſimilar action, as I have frequently experienced, is exerciſed by innumerable other marine animals, which are deſtined by nature to remain fixed in the ſame place. As they are unable to go in queſt of their neceſſary aliment; by means of their arms, or other analogous organs, they cauſe their prey to come to them.

If the water be ſhaken, by accident or purpoſely, the polypi immediately cloſe their arms, retire into their cells, by a round orifice they have at the top, and there lie flat till the water is again at reſt; when they again come out, put forth their arms, and cauſe the little whirlpool, as before. Frequently, likewiſe, they ſuddenly retire into their houſe, when the water, to all appearance, is calm.

The tranſparency of the cells enables us to view the polypi within them. They lie bent like a bow, with their arms grouped together, and are the more eaſily diſcernible, as their bodies have a ſlightly yellowiſh tinge. While they remain within the cell they may, likewiſe, ſometimes, be obſerved to move. Though I have not been able to perceive with certainty that they are attached to the cell by the lower part of the body, I have little doubt but they are; from that part of their body always remaining in contact with one point of the cell, whether the polypus comes out, retires into, or moves itſelf within, the cell.

After ſome days the polypi no more come out of their cells, but ſtill continue to have motion; and a longer time having elapſed, they ceaſe to live, and their carcaſes may be ſeen in the cells half conſumed. In the mean time, new cells ſhoot out, with new polypi, at firſt motionleſs, but which ſoon begin to move, and afterwards come out of their cells, and form, like the others, ſmall

vortices

vortices by the agitation of their arms. By inſpecting Fig. IX. we may ſee that every new cell is attached to an old one a little above the aperture by which the polypus comes out; nor can I entertain the leaſt doubt but the new cell and the polypus it contains derive their origin from a germ or rudiment proceeding from the old polypus, though theſe germs, from their extreme minuteneſs, are not diſcernible by the eye, even with the aſſiſtance of the lens.

This eſchara may be thus characteriſed: *Eſchara membranaceo-calcarea, ramoſa cellulis ovatis ſubcompreſſis, facie una poroſis, polypis retractilibus.*

IV. The animal I ſhall next deſcribe confirms a diſcovery I made in 1786, in the Strait of Conſtantinople, where, while proſecuting my enquiries relative to a variety of inſtructive objects, and particularly the nature and properties of the animals produced at the bottom of that ſea, I diſcovered the circulation of the fluids in various polypi. This

This circulation was ſeen by many intelligent perſons, and among them by the Chevalier Zulian, the Venetian Ambaſſador at Conſtantinople, with whom I had the honour to reſide, and who, as he himſelf poſſeſſes extenſive learning, and liberally patronizes the ſciences, gave me his aſſiſtance in my philoſophical enquiries during my ſtay there.

The circulation of the fluids obſerved in ſeveral polypi of the Strait of Conſtantinople, is confirmed by a polypus found in the Strait of Meſſina. While fiſhing in this Strait, I found, among other ſubſtances, ſome leaves of marine plants, a fragment of one of which having a kind of down on its edge, attracted my attention. On putting it into a concave glaſs filled with ſea-water, I diſcovered it to be a receptacle of polypi. They are repreſented as they appeared to the eye, and of the natural ſize, in Fig. X. in which A B. is the fragment of the marine plant, with the two ſides covered with a multitude of minute polypi. We perceive

that,

that, except the three branching ones, M, N, O, all the other polypi are ſingle, and that every one is attached, by a long leg or ſtalk, to the fragment of the plant A B.

But the form and organization of theſe minute animals cannot be conveniently obſerved without a lens of a conſiderable magnifying power. Fig. XI. repreſents one of them as it appears when viewed with a microſcope while ſtill attached to the marine plant. It appears, however, that this adheſion is not in conſequence of ſmall roots or fibres, but that the foot or ſtem is immediately faſtened to the plant. This ſtem in the upper part enlarges into a pear-ſhaped body, R, E, M, S, which I ſhall call the bell, from the cavity or baſe of which, M, E, ariſes a ſomewhat flattened globule having in the centre an orifice N, which, as we ſhall ſoon ſee, is the mouth of the polypus. Under this globule, and at the baſe of the bell, iſſue the arms of the animal, which terminate in ſharp points, and are fifteen in number, though in polypi of this

this ſpecies they are ſometimes more and ſometimes fewer.

Theſe polypi can draw their arms and the globule into the bell, which they do when the water is ſhaken, or when they are touched; but the reſt of the body and the ſtem are entirely without motion.

The arms, as they now appear, are in a ſtate of reſt and inaction; but the animal can at pleaſure, like the polypi of the eſchara, create in the water a ſmall vortex running towards its mouth. To be convinced that the ſmall aperture N is this organ, it is ſufficient to place it in ſuch a manner that the eye may look perpendicularly down it at the time the ſmall whirlpool is in action. We then ſee that the polypus enlarges, contracts, ſhuts and opens it; and that the ſmall particles brought by the vortex enter into it, and deſcend through a minute continued canal; as may be diſcerned much more diſtinctly if the water be tinged with any colour. In conſequence, likewiſe,

of the different motions of the mouth, the ſmall button or globule, in the top of which it is placed, aſſumes different forms.

The polypi repreſented in Fig. X. were the firſt I obſerved, but not the only ones, ſince I afterwards found many more of the ſame ſpecies on different branches of fucus. The largeſt were four lines in length, and the ſmalleſt half a line; but the latter, in water frequently renewed, ſoon grew to the ſize of the former. Their white colour renders them eaſily diſtinguiſhable by the eye from the bodies to which they are attached; and, when viewed through a lens, they are found to be tranſparent. This tranſparence enabled me to ſee the circulation of their fluids.

Along the foot or ſtem of every polypus (Fig. XI.) we ſee a ſmall column or chain of particles which extend upwards to the extremity of the bell. At firſt, I thought that theſe atoms made a part of the organization of the animal; but I afterwards found that

that they were not fixed but moveable, and deſigned for the ſame function with the red globules of the blood in animals of a ſuperior order. The following is the method adopted by Nature in the motion of theſe minute particles. Every five or ſix minutes they aſcended rapidly from the bottom of the ſtem, and penetrated longitudinally through the middle of the bell M, E, R, S. In the mean time, the number of them in the ſtem diminiſhed, until, at length, very few remained there, the greater part having paſſed into the bell; where they were all in motion, producing a kind of effervescence, which continued ſome ſeconds. They afterwards returned, by the way they had aſcended, to the lower extremity of the ſtem; where they remained at reſt for a ſhort interval; and during this interval it was that I firſt ſaw them, and took them for a ſolid part of the animal. They ſoon, however, reſumed their former motion, aſcending through the ſtem, and collecting in the bell; where the inteſtine ebullition again took place, till the current again deſcended

to

to the bottom of the ſtem, when the ſame alternation of reſt and motion ſucceeded. Thus the maſs of theſe particles moved regularly and conſtantly in the polypi, which it could not have done unleſs we ſuppoſe a canal or longitudinal veſſel, though the tranſparency of the polypi prevented its cavity being diſcernible.

Among ſeveral dozens of theſe polypi, of different ſizes, which I examined, there was not one that did not exhibit this ſpecies of circulation. This, when the animal was in full life and vigour, that is, when it was juſt taken out of the water, was extremely regular, and ſuch as I have deſcribed it; but it altered, more or leſs, when the polypus began to ſuffer by being kept in water not frequently renewed. The motion of the particles then either ceaſed in the middle of their courſe, without recommencing; or, after an interval, began again with difficulty, and laſted only a ſhort time; or, if it continued regularly, it was extremely ſlow. How much do theſe appearances of diſ-

turbed functions correſpond with thoſe of a languid circulation, which I have obſerved and deſcribed in certain animals, both of a cold and warm temperature * ! It is, however, to be obſerved, that this circulation was more diſtinctly viſible when the polypi were viewed on one ſide, than when ſeen on the other; ſince, in the latter caſe, the alimentary canal which runs through the ſtem, being more or leſs filled with ſubtle matters taken in by the polypus, theſe matters ſomewhat obſcure the view of the circulating particles in that place.

I had the curioſity to cut the ſtem of ſome of theſe polypi tranſverſely, and to put others into freſh-water while alive; attentively obſerving the reſults. In the former caſe the particles, which here perform the office of blood, ceaſing their periodical motion, iſſued from the inciſion, in the ſame

* Fenomeni della Circolazione conſiderata nel giro univerſale del vaſi——The Phenomena of Circulation conſidered with reſpect to the whole circuit of the veſſels.

manner

manner as the blood flows from a veſſel that is perforated or cut. In the latter, the circulation ſuddenly ceaſed, the arms became languid and faint, and the body of the polypus ſoon ſuffered diſſolution.

I made another experiment, by putting them in ſea-water of the temperature of 38° (118 of Fahr.), conſequently in a heat much greater than that they experience in the ſea. They all died almoſt inſtantly. But we muſt not be ſurpriſed at this, as the greater part of animals that live in the ſea could not long have ſurvived them in the ſame heat. Theſe polypi, however, continued to live in water kept in veſſels, when the temperature of the atmoſphere was 21° (80° of Fahr.) though a much greater heat than that of the ſea, in which they grow and multiply.

But what efficient principle is the cauſe of this circulation? What force determines the particles to move ſwiftly along the ſtem of the polypi and paſs into the bell? and what

other force obliges them to take the oppoſite courſe? We cannot here have recourſe to the idea of a heart, or any analogous organ, ſuch as, for example, the great artery which runs juſt below the ſkin along the back of many inſects and worms, which, by its ſyſtole, viſibly impels the blood from the poſterior to the anterior part of thoſe animals; at leaſt I never could diſcover any thing ſimilar in the body of theſe polypi. We can only ſuppoſe, at the utmoſt, that the ſides of the bell, diſtended more than uſual by the influx of the particles, on reſtoring themſelves by their elaſticity, may compel the particles to return into the ſtem, where they find leſs reſiſtance; and that the bottom of the ſtem being, in like manner, enlarged by the great quantity of theſe particles, may at length contract by its natural force, and drive them into the upper parts. But this hypotheſis is not only unſupported by proof, but inſufficient to explain the phenomena. From want of data, therefore, I am compelled to leave the problem unſolved.

It

It may, perhaps, be objected that the motion I have described in these polypi is not truly and rigorously a circulation, the particles continually passing and returning within the same vessel; whereas a real circulation supposes a double system of vessels, some of which convey the sanguineous fluid from the centre to the extremities of the body, while others reconduct it from those extremities to the centre.

I must observe, however, that this idea is derived from the animals we call perfect; but it does not hence follow that the circulation in the less perfect may not properly be called by the same name; in like manner as some viscera or organs retain their denomination, notwithstanding that, in their passage from the perfect to the less perfect animals, they may have lost some of their parts. Who is ignorant that the heart in the human species, quadrupeds, and birds, is furnished with two auricles and two ventricles? But shall we, therefore, not call this organ a heart in animals of the amphi-

bious claſs, and fiſhes, becauſe in them it has only one auricle and one ventricle? Is not alſo the arterial veſſel in ſeveral inſects and worms, which continually contracts and expands, called a heart, by Linnæus and other naturaliſts of the firſt eminence, becauſe it is deſigned by nature to perform the office of one? The ſame may be ſaid of the lungs and aſperæ arteriæ, which bear the ſame denominations in the loweſt claſs of animals, notwithſtanding they differ ſo widely in their ſtructure and configuration from thoſe of animals of the ſuperior claſſes. The ſame is true of the circulation. In man, in quadrupeds, and birds, it may be ſaid to be extremely operoſe: but deſcending in the ſcale of animality, it becomes leſs operoſe, the circuits it makes are ſhorter and leſs intricate, until at length it becomes extremely ſimple, the vital fluid going and returning in a ſingle canal, as is obſerved in theſe polypi. Yet is it not on this account to be conſidered as having loſt the character of a true circulation; ſince, in reſpect to the end deſigned, it is equally complete and

perfect

perfect in these animals of the last order, as in those of the first? But of these different systems of circulation, it will be more opportune to treat in the Travels I propose to publish. The work I have before cited, if I am not mistaken, evinces how much I have studied this interesting part of physiological science, as it relates to terrestrial and amphibious animals: that I intend to lay before the public will contain a long chapter relative to this subject, with respect to marine animals.

I shall conclude my description of this polypus by remarking, that I think I am authorized to consider it as a new species; since it has not, to my knowledge, been described by any other writer. It may be thus characterized: *Polypus nudus, sæpius simplex, pedunculatus, affixus, corpore campanulato, cirrhis subulatis retractilibus, circulationem humorum exerens.*

V. We will now proceed to a fifth animal of the order of molluscа, found at the

bottom of the ſea, which, though it be well known, deſerves attention for the elucidation it affords of a queſtion agitated among naturaliſts, and not yet completely determined. We know that the *echini marini*, or ſea-urchins, are molluſca, armed with very thick ſpines; and it is alſo known, that they are provided with a prodigious quantity of ſmall tentacula, which they put forth and conceal at pleaſure: but which of theſe perform the office of feet, and enable theſe animals to move progreſſively, is not ſatisfactorily decided; ſome aſcribing this motion to the action of the ſpines, and others to that of the tentacula.

Some years ago, I made a number of experiments in the Gulph of Spezia, with a view to elucidate this queſtion; of which I gave ſome account in the Memoirs of the Societa Italiana *, reſerving the details till I publiſh the obſervations I made in the Sea of Genoa. The ſum of the principal reſults is as follows.

* Tom. ii. p. 2.

If

If the echini are taken out of the water, as they will live out of it a little time, the ſlow and ſhort progreſſive motions they make are performed ſolely by means of their ſpines; but ſo long as they remain in their native element, their removal from place to place is effected entirely by their tentacula.

I took five *echini ſpatagi* which were brought up by the coral fiſhermen, and put them immediately into a bucket of ſea-water, in order to examine them on my return to Meſſina a few hours afterwards. By the way, I obſerved, that, notwithſtanding the agitation of the water, cauſed by the motion of the bark, they had all five aſcended from the bottom of the bucket up the ſides, almoſt to the top, where they remained attached by means of their tentacula. I then perceived that the tentacula were not only of uſe to faſten theſe animals, but to enable them to remove from place to place; as the ſpines, from their rigidity, could not have contributed to their aſcent. I detached them with ſome difficulty, and, to diſcover the

the nature of the mechaniſm of their motion, placed them at the bottom of a glaſs veſſel with ſmooth and perpendicular ſides. I firſt directed my attention to one which I had laid in an inverted poſition, that is, with its mouth turned upwards; for, when in their natural ſtate at the bottom of the ſea, they always have that part downwards. This poſture being a violent one, the animal endeavoured to turn himſelf. On one ſide he thruſt out fifty or more tentacula, extending them as much as he could, and fixing them to the bottom of the veſſel. He then contracted them, and by the contraction ſomewhat raiſed his body. He was now, as it were, on one ſide, and remained in that poſition, by holding faſt with the contracted tentacula. He then put forth other tentacula on the ſame ſide, which he again fixed to the bottom, and contracting them, and detaching the others, made another part of a revolution with his body. When he had performed this curious operation three times more, his mouth, which before was placed upwards, became turned downwards, and he thus

thus recovered his natural poſition. Theſe motions therefore were effected by the tentacula, and the ſpines had no other part in it than by ſeparating and giving the tentacula liberty to act.

The animal afterwards, by the ſame means, came under the ſides of the veſſel, which he aſcended with conſiderable expedition quite to the top, ſo as to riſe five or ſix lines above the ſurface of the water. In this aſcent he only employed the tentacula by extending and contracting them as before.

In fact, I fully convinced myſelf that the ſpines had no kind of part in theſe motions, by cutting them off; ſince then the echini, when placed in an inverted poſition, could ſtill turn themſelves, and move in the ſame manner as before, either along the bottom, or up the ſides of the glaſs, by the action of the tentacula.

I have ſaid before, that theſe animals were detached with ſome difficulty from the ſides

of

of the veſſel. I wiſhed to try what weight would be requiſite to force them from the glaſs; and I made the trial with one of them, which had faſtened to the top of the ſides of the glaſs, and roſe nearly half an inch above the ſurface of the water. I laid on his ſpines a piece of lead weighing thirty-two ounces; notwithſtanding which he ſtill held firm, and it was neceſſary to add ſeven more ounces to force him from his hold. It required therefore a weight of thirty-nine ounces to detach the tentacula from the glaſs.

But what ſhall we ſuppoſe to be the cauſe of ſo ſtrong an adheſion to bodies of ſo great ſmoothneſs as glaſs? The following obſervations will elucidate this queſtion.

If we view the tentacula through the ſides of the glaſs-veſſel at the time the echinus ſtretches them out, and before he fixes them, we ſhall find that they are of a white colour, that each of them terminates in a papilla perforated in the middle; and if we

cut the tentaculum off at the root, and view it with the microſcope in a horizontal poſition, we ſhall perceive that this orifice is the extremity of a canal, which runs from the bottom to the top of the tentaculum, and enters into the body of the animal. If alſo we preſs the tentaculum with a ſmall wire, or other inſtrument, a little drop of denſe and extremely viſcous liquor will iſſue from the orifice. With this gluten the echini, there can be no doubt, faſten themſelves where they pleaſe. The tranſparency of the tentacula enabled me, with the aſſiſtance of a lens, to ſee, through the ſides of the veſſel, the means the echini employ to obtain ſo ſtrong an adheſion. They apply to the ſides the papilla of the tentaculum, and from that point expel the ſea-water. The orifice of the papilla then enlarges and becomes deeper, forming a ſmall cavity, which a moment after is filled with the glutinous matter, which faſtens the tentaculum to the glaſs. The ſame takes place in every tentaculum; and thus the echini are as it were bound

bound to the glaſs by ſo many ſmall cords as there are tentacula which touch it.

Reaumur obſerved, that the patellæ (limpets), to detach themſelves from the ſubaqueous rocks, to which they adhere tenaciouſly, throw out a kind of water which held them faſtened. This water I never ſaw iſſue from the papilla of the tentaculum, though I uſed the ſtrongeſt magnifiers. It appears to me, that the echini employ other means to free themſelves with facility from their faſtenings, which are, by ſhaking the tentaculum, and turning the papilla obliquely, in ſuch a manner that the water enters between it and the glaſs, which in a moment diſſolves the gluten.

We have thus ſhewn that the offices of the tentacula in theſe echini are two; one, to ſerve them as feet to remove from place to place; and the other, to hold them anchored where they chooſe at the bottom of the ſea. Such a proviſion was very neceſ-

ſary

ſary for the echini in every ſea, to enable them to reſiſt the fury of tempeſts, but eſpecially for thoſe of the Strait of Meſſina, which is ſo frequently liable to ſtorms. Without it they muſt be the ſport of the waves, and would be carried away and broken, from their extreme fragility.

It remained for me to make ſome experiments on them when kept out of the water. It is certain that then they never put out a ſingle tentaculum; and that, therefore, if they have any progreſſive motion, it can only be performed by means of their ſpines. I placed two of them on a horizontal plane; at firſt with their mouths turned upwards, as I had done by the others. They immediately began to move their ſpines in every direction, endeavouring to recover their natural poſture, but always in vain. Their fruitleſs attempts reſembled thoſe of the tortoiſe when laid on its back; and, like that animal, they removed a little from their place, though with much greater ſlowneſs. When they were turned with their mouths down-

wards, the ſpines under their bodies were in a ſlow, but almoſt continual, motion; by which means, with great difficulty, they changed their place, but made a very ſlow progreſs.

Theſe obſervations relative to the echinus ſpatagus, which have not been before made, to my knowledge, on any ſpecies of this genus, agree, in all that is eſſential, with thoſe I made on the echinus eſculentus. From them it appears that thoſe are in an error who ſuppoſe the ſpines the only inſtruments of motion in the echini; as alſo thoſe who aſcribe this office ſolely to the tentacula; ſince the motive principle is divided between them; but with this difference, that it reſides in an infinitely leſs degree in the ſpines than in the tentacula.

I ſhall omit to notice the madrepores, cellularia and ſertularia, which are brought up from the bottom of the ſame Strait, both becauſe they are ſpecies already well known, and becauſe I had not ſufficient leiſure to examine

examine their polypi while employed in the obſervations I have already detailed. I have only mentioned theſe animated productions to ſignify that they are found in the Strait of Meſſina.

CHAP. XXIX.

OF THE CORAL FISHERY IN THE STRAIT OF MESSINA.

This fiſhery extremely laborious and dangerous—Deſcription of the net uſed in this fiſhery, and precautions neceſſary in throwing it into the ſea—Parts of the Strait in which the coral is found—Different depths from which it is brought up—Situations in which it moſt abounds, and is fiſhed up in greateſt quantities—Compariſon of this coral with that of Trapani and Barbary—Variety of its colours—Ten years requiſite for it to attain maturity—Profit annually derived from it—Theſe obſervations compared with others publiſhed by the Count Marſigli relative to this animal-plant—This compariſon ſhews, Firſt, that it is not always true, as the Count believed, that the ſituations proper for the growth of coral are thoſe where the ſea is calm: Secondly,

Secondly, that it will thrive at a greater depth than he has ſuppoſed: Thirdly, that it is not true that where coral grows moſt readily it ſcarcely reaches the height of half a foot in ten years: Fourthly, that it is not true that corals only grow in the roofs of caverns, and that their branches are always turned towards the centre of the earth: Fifthly, that the corals brought up in this fiſhery are not red only, but of other colours; as, for inſtance, white; notwithſtanding the Bologneſe naturaliſt was of a contrary opinion—In proof of this, a ſeries of coralline branches of different colours, brought up in this Strait, are deſcribed—Proof that the white coral does not differ from the red, except in colour—The error of Marſigli that the polypi are flowers, has given occaſion to the diſcovery of a truth equally unexpected and important—Probable opinion of the Meſſineſe coral-fiſhers, that the immature coral has leſs conſiſtence than the mature; though it is not true, as the ancients believed, that corals while they remain in the ſea are ſoft,

and harden when they come in contact with the air. In what ſenſe we are to underſtand the obſervation of Donati, that the broken and detached branches of coral continue to live and multiply in the ſea—The true generation of coral not unknown to the Meſſineſe coral-fiſhers—Their opinion with reſpect to dead corals which are ſometimes perforated by lithophagous worms.

THOUGH this narrow part of the ſea is always more or leſs in a ſtate of agitation, its bottom is, at every ſeaſon of the year, ſearched for that valuable animal-plant, the coral (*Iſis nobilis*), provided the winds and current be not ſo violent as to endanger the barks of the coral-fiſhers. The latter are always mariners and fiſhermen of Meſſina, as it is neceſſary they ſhould be both well acquainted with theſe ſeas, and have great bodily ſtrength; this fiſhery, beſides that it is frequently dangerous, being extremely laborious, ſince great exertions with the oar are neceſſary to reſiſt a ſea always in motion; and

and there are perhaps no people who endure the labour of the oar equal to the ſailors of Meſſina.

The inſtrument they employ to tear from the rocks the branches of coral, does not differ eſſentially from that repreſented and deſcribed by Count Marſigli, in his *Hiſtory of the Sea* *, and which is uſed, likewiſe, in other countries. It is formed with two poles of wood, croſſing each other at right angles, and to the extremities of which, on the under ſide is faſtened a piece of a net. A large ſtone is faſtened where the poles croſs each other, that it may the more readily ſink to the bottom. A cord is ſtrongly tied round the middle of it, one end of which the fiſherman holds in his hand, and by it guides the net to thoſe places where the coral is ſuppoſed to grow; and which is encloſed in the pieces of the net, broken off, and drawn up.

* Storia del Mare.

I have ſaid that this coral net does not differ eſſentially from that deſcribed by Marſigli. It may not be improper, however, to obſerve, that the net of the Meſſineſe fiſhermen is larger, and ſunk with a greater weight. This is intended to prevent its being carried away by the violence of the current before it reaches the bottom. It is, beſides, always thrown from the ſtern, and never from the ſides; as repreſented in the figure given of it by Marſigli; perhaps on account of the danger that the weight of the net, concurring with the force of the current, ſhould overturn the bark.

This fiſhery is carried on from the entrance of the Faro, to the part of the Strait oppoſite the church of the Grotto *(Chieſa della Grotta)*; that is, through a tract ſix miles in length, and to the diſtance of three miles from Meſſina. Beyond theſe limits they never fiſh; either becauſe there are no rocks on which the coral grows, or becauſe they lie ſo deep as not to be reached by the net; or, perhaps, becauſe

becauſe the violence of the current prevents the barks from continuing there a ſufficient time *.

Within theſe ſix years, indeed, two rocks have been diſcovered eight miles to the ſouth of that city in front of the channel of San Stefano, which bear excellent coral in great abundance. Except the Strait, this fiſhery is now carried on in no other place.

The rocks which produce the coral are ſituated almoſt in the middle of the Strait, at different depths, from three hundred and fifty feet to ſix hundred and fifty. This depth increaſes as we approach the mouth of the Strait, where there is no longer any fiſhing; the rocks there, according to the coral-fiſhers, being a thouſand feet deep.

* I was told by an old ſailor, that there was once a fiſhery for coral between Stromboli and Cape Vatican; but that it was abandoned becauſe it was extremely dangerous for the barks, which had no ſhelter from the wind when it blew from the weſt, north-weſt, or ſouth-weſt.

The hollows and caverns of the rocks are the places from which they endeavour to bring up the coral with their nets; not but it likewiſe grows out of theſe, and on the ſides of the rocks; but uſually in leſs quantity. It is a conſtant obſervation, that every branch is perpendicular to the plain on which it grows, without ever turning on one ſide.

Coral grows more plentifully in places ſituated to the eaſt than in thoſe to the ſouth; it is rarely found to the weſt, and never to the north. In the firſt ſituation, therefore, it is larger, and of a finer colour than in the ſecond and third; which two valuable qualities are likewiſe found in that which is brought up from a leſs depth, compared with that which grew at a greater. The greateſt height to which it grows is never a foot, and its uſual thickneſs that of the little finger, and ſomewhat leſs than that of the coral of the coaſts of Trapani and Barbary; but the latter are exceeded by the Meſſineſe in vividneſs of colour. Theſe differences, according

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to the account of the fiſhermen, ariſe from their coral being produced in a ſea which is kept in continual motion, from the ſurface to the bottom, by the current and the winds.

With reſpect to colour, there are three kinds; the red, the vermilion, and the white coral. The firſt is ſubdivided into the deep crimſon red, and the lighter red. The vermilion is extremely rare, but the white common. In the white they include the clear white and the dull white.

The coral fiſhermen have divided the whole tract in which they fiſh into ten parts. Every year they fiſh only in one of theſe parts, and do not fiſh in it again till ten years are elapſed. This interval of ten years they think neceſſary for the coral to acquire its full growth in height and conſiſtence. When they tranſgreſs this law, they find, in fact, the coral ſmaller, and of leſs conſiſtence, and the intenſity of the colour is always in proportion to the number of years they have deſiſted from fiſhing. When the ten years

have elapſed, they believe that the coral no more increaſes in height, but only in thickneſs, which, however, has its limits. In fact, they have obſerved that the coral fiſhed up near San Stefano, a place where none had been ſought for in the memory of man, though it was of a very bright colour, was not higher than the ordinary coral, though it exceeded it by one third in thickneſs.

The number of ſhips which uſually go together in this fiſhery is eighteen or twenty, each of which is uſually managed by eight men. The quantity of coral procured may amount every year to twelve Sicilian quintals. The quintal, as is well known, contains two hundred and fifty pounds, and the pound twelve ounces. The gain acquired is therefore adequate to the labour; yet may the fiſhery be conſidered as a ſecondary occupation, ſince the fiſhermen only follow it when they have no other employment by which they can make a greater profit.

It is evident that the account I have here given

given can be derived from no more certain ſource than the relation of the fiſhermen themſelves. I was deſirous to be preſent at a fiſhing, and one was undertaken expreſsly to gratify my curioſity. As the branches of coral were taken out of the nets, I put them into glaſs veſſels filled with ſea-water. It is well known that, in this caſe, the white polypi will come out of their cells in the coral as ſoon as the water is perfectly at reſt. I examined and re-examined theſe polypi, as it was the firſt time I had ſeen them; but I diſcovered nothing which can make any addition to the accurate obſervations of Peyſſonel, Juſſieu, Guettard, Donati, and the very recent remarks of the celebrated Cavolini, which ſeem to leave nothing to be deſired to complete our knowledge of theſe animalcula, and their natural habitudes. But the obſervations I have already given above, enable me to add to, and, in part, to correct thoſe of our illuſtrious naturaliſt Count Ferdinando Marſigli, relative to the preſent ſubject.

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The ſituations, according to him, favourable to the vegetation of coral, are thoſe in which the ſea is as calm as a pond; and it is found in greater abundance if they are expoſed to the ſouth, in leſs if they front the weſt, and totally fails if they have a northern aſpect.

As to the firſt of theſe obſervations, it has already been ſeen that it is not always true: coral growing, and coming to perfection, in a ſea conſtantly diſturbed and agitated, as is that of the Strait of Meſſina; except only that it does not acquire that degree of extenſion it attains to in other places.

The ſecond obſervation agrees with the remark of the fiſhermen of Meſſina, except that the latter affirm the eaſtern aſpect to be more favourable than any other to the growth of coral; while in the maritime places examined by Marſigli it was found in greateſt quantities to the ſouth.

He aſſerts that the leaſt depth at which coral grows is ten feet, and the greateſt ſeven hundred and fifty; but that it is moſt uſually brought up from between the depths of ſixty and one hundred and twenty-five feet.

We have already ſaid, that the depth from which the coral is fiſhed up near Meſſina is from three hundred and fifty feet to ſix hundred and fifty; not that coral cannot grow at a leſs depth than three hundred and fifty feet, but becauſe this is the leaſt depth of theſe rocks. It is probable alſo, that it grows at a ſtill greater depth than ſix hundred and fifty feet; but it being extremely laborious and fatiguing to fiſh at ſo great a depth, the mariners do not attempt it. Their obſervations, therefore, do not claſh with thoſe of Marſigli, relative to the greateſt and leaſt depth at which coral is found; but they diſagree with reſpect to the depth between ſixty and one hundred and twenty-five feet, in which we are told by Marſigli coral moſt uſually grows, as it is found

found in equal plenty in much greater depths, that is, from three hundred and fifty to ſix hundred and fifty feet.

The fiſhermen from whom the above-cited naturaliſt received his information, were of opinion, that, in the ſituations moſt favourable to its growth, it ſcarcely, in ten years, attains to the height of half a foot.

Their aſſertion is probably ſupported by ſome fact, and I therefore ſhall not pretend to doubt it; but I muſt ſay that it cannot be conſidered as univerſally true, as the corals of Meſſina in that time attain their greateſt height, which is nearly a foot. This is ſufficiently corroborated by the corals of San Stefano, where, as that part of the Strait had never been fiſhed, they have had ſufficient time to arrive at their complete natural maturity. They are there thicker, but not higher, than the corals obtained, after the expiration of the ten years allowed, from the rocks where the fiſhery has been carried on from time immemorial.

Marſigli

Marſigli tells us that corals are produced and grow only in the roofs of ſubmarine caverns, and that their branches are always turned towards the centre of the earth.

That coral grows from the roofs of ſubaqueous caverns, and in an inverted poſition, is frequently obſerved; but we likewiſe know that it grows out of ſuch caverns; and fixes itſelf in any place, either to ſtones at the bottom of the ſea, the abandoned remains of ſhell-fiſh, or any other ſolid body; and then it has never an inverted poſition. In the different draughts made by the fiſhermen while I accompanied them, their nets frequently brought up the ſhells of dead oyſters and other ſhell-fiſh, to which ſmall branches of coral adhered. It is only a few years ſince a broken earthen veſſel was brought up in their net, the internal ſurface of which was covered with branches of coral, with their tops directed towards the orifice, through which a part of them iſſued. When ſpeaking of the coral fiſhery carried on round Lipari, I have ſaid that, under the caſtle, a

branch of coral was fiſhed up which grew on a piece of volcanic enamel *.

Theſe facts not only prove that coral grows out of theſe marine caverns, but alſo that its branches very frequently grow upwards.

According to the obſervations of Marſigli, the natural colour of coral is between a deep red and a light carnation; recent coral of a white colour, or that of milk, he adds, he never ſaw. He tells us, however, that red colour, if the coral be boiled in wax or milk, becomes white. M. Pallas writes, that he had ſeen in the Britiſh Muſeum a large branch of coral of the colour of milk, and another of a vivid fleſh-colour; but he will not warrant that thoſe colours were natural †.

The coral-fiſhermen of Meſſina teach us that the aſſertions of the Italian naturaliſt,

* See Chap. XXIV. † Elem. Zoophyt.

and

and the doubts of the Academician of Peters-burg are alike without foundation. In the Strait of Meſſina they frequently find white as well as red coral. While I accompanied them when fiſhing, all the coral they drew up was red; but, before I left Meſſina, my learned friend, the Abbate Grano, knowing how much I wiſhed to procure ſome branches of white coral, obligingly preſented me with a ſeries of coralline branches, of different colours, from thoſe which are more or leſs red to a dark aſh-colour, and from that to a clear white. Of theſe branches, which now make a valuable addition to the claſs of Zoophyta in the Imperial Muſeum at Pavia, I ſhall proceed to deſcribe the principal.

I. The bark of this branch has the colour of ſealing-wax; but the ſolid coral is purple, with ſome tranſparency at the extremity of the branches.

II. The bark in colour reſembles that of

the foregoing; but the included ſolid coral is of a leſs vivid red.

III. The bark is of a blueiſh grey; the ſolid coral grey, with a ſlightly reddiſh tinge.

IV. In this ſpecimen four branches ſhoot from the ſame ſtem; two of a pale red in the bark, and a whitiſh red in the ſolid coral. In the fourth the bark is of a whitiſh colour, and the ſolid coral ſtill whiter.

V. Three branches joining in one, the colour of which, both in the bark and the ſolid coral, is a milky white.

Beſides theſe curſory obſervations on the colour, I ſhall likewiſe make a few others on the ſtructure of the cortical and ſolid parts of the white corals. They are inveſted with a white and friable bark, which may be ſcraped with the nail, and which,

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in ſome corals, where it is in beſt preſervation, riſes in conical tumors, open at the top with an octoradiated orifice, the mouth of the cellules which were once the habitations of the polypi.

The internal ſubſtance of the coral, which may be called the ſkeleton or bone of the animal, is ſulcated on the ſurface with thin longitudinal ſtriæ, has the ſolidity of hard ſtone, and, when broken tranſverſely, appears lamellar. The nitric acid decompoſes and entirely diſſolves it, with a ſtrong effervescence as if it were a calcareous carbonate.

Theſe obſervations on the white coral prove its perfect reſemblance to the red: or, to ſpeak more properly, its identity with it; as no other difference is diſcoverable between them but the acccidental one of colour.

The orifices of the cells in the bark of the white coral being octoradiated like thoſe in the red, appears to be a proof that the

polypi in both are of the ſame ſtructure, and, conſequently, of the ſame ſpecies; the polypi inhabiting the red coral having likewiſe eight tentacula.

I have not made theſe remarks to depreciate what has been written by this celebrated Italian on the ſubject of coral. Notwithſtanding the egregious error he has committed in taking the polypi of the coral to be flowers, ſuppoſing with the generality of botaniſts that it was a plant; his obſervations on the whole deſerve great praiſe.

That coral is ſoft in the ſea, but hardens when it comes in contact with the air, was the opinion of the ancients; but has been proved falſe by the obſervations of the moderns. The coral-fiſhermen of Meſſina, who derive all their knowledge from experience only, are convinced this opinion is erroneous; but they aſſert that coral which has not attained maturity has not that degree of conſiſtence it acquires when it has arrived

arrived at its full growth. The truth of this poſition I was not able to aſcertain, as, for that purpoſe, it would have been neceſſary to caſt the net in one of thoſe ten parts of the Strait in which it is prohibited by the law to fiſh till the expiration of the ten years preſcribed. Yet the rules of analogy derived from what is obſerved in all animals and vegetables, incline me to favour this opinion.

The coral-fiſhermen who were conſulted by Marſigli, and thoſe of Meſſina from whom I derived my information, both agreed that the deeper we deſcend into the ſea, the ſmaller is the coral; and ſome years ago I made enquiry relative to this ſubject of ſome other fiſhermen, who go to fiſh for coral on the coaſts of Barbary, and near Sardinia and Corſica; and they likewiſe confirmed the aſſertion. This obſervation, therefore, appears to be univerſal and conſtant. But to what are we to attribute this difference? Were coral brought up only from places to which the heat, or

at leaſt the light, of the ſun can penetrate, we might ſuſpect that one or the other of theſe two principles might more or leſs influence its growth. But it appears certain that corals grow even in thoſe bottoms to which not an atom of ſolar heat, much leſs light, can penetrate; if the calculations of a celebrated philoſopher are accurate, who aſſerts that the light of the ſun does not enter deeper into the water of the ſea than ſix hundred feet, and that his heat does not reach to a quarter of that depth. Yet coral is fiſhed up, according to the obſervations of Marſigli, from the depth of ſeven hundred and fifty feet. If we reject, then, theſe two principles as inſufficient, it will be very difficult to diſcover what other can cauſe the greater growth of coral at a leſs depth.

I have ſometimes thought that the preſſure of the water at theſe great depths might poſſibly be an impediment to its development. But this idea by no means accords with the birth and growth of numerous minute plants and worms not at all inferior in the

the delicacy and tenderneſs of their bodies to the polypi of coral.

Donati obſerves, that the broken and detached branches of coral will continue to live and multiply within the ſea. This I do not heſitate to believe, provided they meet with a firm point of ſupport to which they can attach themſelves with their viſcous humour. Otherwiſe, if they fall on the moveable ſand, they become the ſport of the waves, and I cannot doubt but they muſt periſh. Such was the caſe, I am of opinion, with two branches deprived of their bark, and conſequently dead, which were fiſhed up when I was preſent. I was likewiſe confirmed in this opinion by the coral-fiſhermen, who told me that they had frequently drawn up from the bottom of the ſea coral growing and alive, but always attached by its trunk to a ſhell-fiſh, a ſtone, or a fragment of an earthen veſſel, but never to pure ſand. I perceived, likewiſe, with ſome degree of pleaſure, in the courſe of theſe converſations with the coral-fiſhermen, that they were not

unacquainted with the true generation of coral; as they told me that they had frequently obſerved, on hard matters drawn from the bottom of the ſea, the firſt principles of coral beginning to germinate; which they deſcribe as having the appearance of a red ſpot, with a button or bud implanted in thoſe matters, ſometimes tender and fragile, and ſometimes hardened, and of the colour and nature of ordinary coral.

They were likewiſe acquainted with thoſe branches of coral which, when fiſhed up, are ſometimes found perforated by lithophagous worms, and which are mentioned by Vitaliani and Marſigli. Their nets had frequently brought them up, either from the bottom of the ſea, from caverns, or the ſides of rocks; and theſe perforated corals were found ſometimes broken in the trunk, where the perforations are moſt frequent; and at other times attached to ſome body which ſerved them as a baſe. They were of opinion that theſe corals were thus perforated, becauſe they were dry; and this dryneſs,

they imagine, proceeds either from age, or their having been broken from their root by ſome fiſh, or by a part of a rock falling on them; or poſſibly by the coral nets, which do not always bring up all the branches of coral they tear away from their roots.

CHAP. XXX.

OF THE FISHERY OF THE SWORD-FISH, IN THE SAME STRAIT.

Two methods of taking the ſword-fiſh: with the lance, and the net called palimadara—*At what time the lance is made uſe of—Periodical paſſage of this fiſh through the Strait, ſometimes on the coaſt of Calabria, and ſometimes on that of Sicily, according to the difference of the ſeaſons—It appears certain that this fiſh propagates in the Sicilian and Genoeſe ſeas—The lance only uſed for ſword-fiſhes of a large ſize—Thoſe of every ſize taken with the palimadara—Great deſtruction made of fiſh in general by this net, from its taking thoſe which are very ſmall—A ſimilar deſtruction occaſioned in the Sea of Genoa by the fiſhery with the bilancelle—Singular kind of bark for throwing the lance, and carrying the apparatus neceſſary*

neceſſary for taking the ſword-fiſh—Manner in which the fiſhermen diſcover and take it—Uſual weight of the fiſh of this ſpecies taken in the Strait of Meſſina.

I PRESUME it will not be unacceptable to my readers to peruſe a brief account of two other fiſheries which are carried on in the ſame ſea with that for coral which I have juſt deſcribed. One of theſe is for the ſword-fiſh; and the other for the ſea-dog (or ſhark). They will form the ſubject of the preſent and following chapter.

The ſword-fiſh *(Xiphias Enſis Linn.)* is taken by the Meſſineſe ſailors in two ways; that is, with the lance, and with the *palimadara*, a kind of net with very cloſe meſhes. This fiſhery begins about the middle of April, and continues till the middle of September. From the middle of April to the end of June it is carried on upon the coaſt of Calabria; and from the end of June to the middle of September on that

that of Sicily. The reaſon of this is that, by the account of all the fiſhermen, the ſword-fiſh, from April till June, entering by the Faro, coaſts the ſhore of Calabria without approaching that of Sicily; and paſſes the contrary way from the end of July to the middle of September. We know not whether it takes this contrary route for the ſake of food, or from any other cauſe; or whether it be the ſame fiſh which thus paſſes and repaſſes: it is only certain that it does not coaſt the ſhore of Sicily but when it goes to ſpawn, when the males may be ſeen ſwimming after the females, one of which is frequently accompanied by ſeveral males. At this time the fiſhermen, likewiſe, have the moſt favourable opportunity for taking a double booty; as, when the female is killed, the males will never leave her, and are conſequently eaſily taken.

It ſeems almoſt certain that the ſword-fiſh propagate their ſpecies in the Sicilian Seas, and alſo on the Coaſt of Genoa. They are every year taken in the Strait of Meſſina, from

from November to the beginning of March, of the weight of from one pound to twelve; and at the latter end of autumn, and in winter, I have ſeen ſmall ſword-fiſh ſold at Genoa which were taken in the neighbouring ſea.

It is true that, in the Strait of Meſſina, ſword-fiſh of ſo ſmall a ſize were not formerly taken; not, I am perſuaded, becauſe they did not paſs the Strait, but becauſe the inſtruments for fiſhing which have been in uſe of late years were not then invented; eſpecially the palimadara. This is a net eighty feet or more in length, and fifteen in breadth, made with ſtrong cords and cloſe meſhes, ſo as to take fiſh of every ſize; whereas with the lance, which was formerly the only inſtrument employed in this fiſhery, the largeſt alone, which riſe to the ſurface, can be taken. And this probably is the reaſon why the quantity of large ſword-fiſh taken with the lance has of late years diminiſhed; this premature fiſhery having deſtroyed prodigious numbers of theſe fiſh, and at the ſame time prevented their reproduction.

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A ſimilar wanton and waſteful deſtruction of fiſh I have noticed in other parts of the Mediterranean, and eſpecially near Portovenere, on the Genoeſe coaſt; where they fiſh with the *bilancelle*. By this name are called two veſſels with a large lateen ſail, placed oppoſite to each other at ſome diſtance, to which is faſtened by two large cables a net of prodigious extent, which reaches to the bottom of the ſea, and having very fine meſhes, confines within it fiſh of every ſize, when it is drawn along by the motion of the veſſels impelled by the wind; for without wind this method of fiſhing cannot be attempted. When during the ſummer vacation in 1783 I employed myſelf in the vicinity of Portovenere in making reſearches into the nature and properties of various marine animals which are indigenous in that ſea, the reſult of which enquiries I afterwards publiſhed in the Tranſactions of the *Società Italiana;* I went with the veſſels employed in this mode of fiſhing ten or twelve times, it being particularly adapted to the object I had in view; and I obſerved that, beſides

beſides fiſhes of a large or a middling ſize, an immenſe number of extremely ſmall ones were taken, which, being of no value, were again thrown into the ſea, but not till they were dead, and almoſt torn to pieces by the rubbing of the net; and I could not avoid reflecting on the ſerious injury done to every kind of fiſhery by the deſtruction of ſuch prodigious quantities of fiſh before they arrived at maturity. It is true, I was told there was a law at Genoa which prohibits the uſe, or rather the abuſe, of the bilancelle. This, however, appears ſcarcely credible, when we ſee every year, in the ſummer time, three or four pairs of theſe veſſels ſail out to ſea, in the Gulph of Spezia, to engage in this kind of fiſhing. The magiſtracy of the place, beſides, whoſe duty it is to prevent the ſailors from engaging in this injurious fiſhery, may be eaſily gained over to connive at it, for a ſum of money, eſpecially if the largeſt fiſh are every day ſent to them, to prevent the veſſels from ſinking by being overladen.

When I arrived at Meſſina, the palimadara was not made uſe of, and the fiſhery for the

ſword-fiſh with the lance was nearly at an end. For the latter mode of fiſhing the mariners make uſe of a kind of veſſel they call *luntre*, which is eighteen feet long by eight wide. The prow is wider than the ſtern, in order to give more room to the man who throws the lance. In the middle is fixed an upright pole ſeventeen feet high, with ladders to go up it, and a kind of round platform at the top, for one of the crew, who acts as ſentinel, to ſtand on. This platform is called *fariere*. Near the bottom this pole is croſſed at right angles by another, ten feet long, the extremities of which reach a foot and a half beyond the ſides. To the ends of this pole or beam are faſtened two oars, each twenty feet long. Theſe oars are managed by two ſailors, while a third ſtands in the middle, holding the right oar in his right hand, and the left in his left; who acts as pilot, and directs the veſſel ſometimes to this ſide and ſometimes to the other. This part is performed by the ſame ſailor who from the *fariere*, or round top, firſt diſcovered the

the ſword-fiſh, obſerved its courſe, and pointed it out to the rowers; for, beſides the two already mentioned, who row alternately, according to the impulſe or directions of the third, there are two others, who, with ſmaller oars, row continually at the ſtern, following the fiſh, which makes a thouſand turnings and windings, and ſeems to wiſh to play with the veſſel as it ſails. The lance uſed to ſtrike the fiſh, is made of the wood of the lime-tree, which does not eaſily bend. It is full twelve feet long. The iron head affixed to it, which the ſailors call *freccia*, is ſeven inches long, and has on each ſide two pieces of iron called ears, equally ſharp and cutting, but moveable. Theſe are united to the principal iron till the lance is thrown; when they fly open, make the wound larger, and fix the iron head more firmly in the body of the fiſh. The iron head is not faſtened immoveably to the wood, but fixed in ſuch a manner, that when the ſtroke is made it buries itſelf in the body of the fiſh, and is detached from the wood, but ſo that both the wood and the head re-

main faſtened to a rope which is held firmly by one of the ſailors, while the wounded fiſh is dragged after the veſſel. This rope is of the thickneſs of the little finger, and ſix hundred feet long.

This apparatus, however, is not ſufficient. When the ſword-fiſh coaſt the ſhore of Calabria, two other men are placed to watch on the rocks and cliffs which riſe out of the ſea. A ſimilar practice is neceſſary when the fiſh come down the coaſt of Sicily; but there, as there are no rocks, theſe ſentinels take their ſtation on maſts eighty feet high, erected in veſſels of the largeſt ſize, anchored near the ſhore, and about a ſtone's throw diſtant from each other.

The manner in which this fiſhery is conducted is as follows: When the two men who watch on the rocks or maſts of the veſſels ſee the fiſh approaching, which, as they ſay, they perceive by the change of colour in the water, they ſignify it by ſhouts to the crew of the fiſhing veſſel, which immediately

diately bears down and is directed by the ſhouts and ſignals of theſe men, till the man on the round top has diſcovered, and follows them with his eye. By his directions the veſſel is tacked to one ſide or the other, while the man who is to throw the lance ſtands ready in the prow, till they come up with the fiſh; when the other comes down from the round-top, and, placing himſelf between the long oars, guides the veſſel according to the ſignals or directions of the lancer, who, having found a favourable opportunity, ſtrikes the fiſh, ſometimes at the diſtance of ten feet, immediately lets go the rope he holds in his hand to give the fiſh ſcope to run, or, as they term it, *calma*. The men then row with all their might, following the courſe of the wounded fiſh, till he grows faint and is nearly dead, which they know by his coming up to the ſurface of the water. They then approach him, drag him with an iron hook into the boat, and carry him to land.

Sometimes the fiſh, enraged by the wound

he has received, turns upon the veſſel, and endeavours to pierce it with his ſword; and when the fiſh is of conſiderable ſize and ſtrength, the fiſhermen are obliged to be very careful of this, as ſeveral ſerious accidents have happened from ſuch attacks.

Sometimes the wounded fiſh eſcapes, either becauſe the lance has not penetrated deep enough, or becauſe, the rope breaking, he has carried it away infixed in his body. When the wound is ſlight, it ſoon heals; many fiſh having been taken with more than one ſcar; but if it be deep, he inevitably dies, and becomes the prey either of other fiſh, or the firſt fiſherman who meets with him. The uſual weight of the ſword-fiſh is from one hundred to two hundred pounds; but ſome have been taken which have weighed three hundred.

CHAP.

CHAP. XXXI.

FISHERY OF THE SEA-DOG (A SPECIES OF SHARK) IN THE SAME STRAIT.

Different species of squali (or sharks).—This fishery dangerous from the large sharks which sometimes frequent this Strait, especially the formidable squalus carcharias *(the white shark)—Accidents which have happened by their voracity within the harbour of Messina, and in several parts of the Mediterranean—Enormous opening of the mouth of the larger shark, sufficient to swallow a whole man—Entire bodies of men sometimes found in their stomachs—Parts of a large shark sent to the author after his return from the Strait of Messina—Its characters, taken from the exterior habit of the body—Several rows of teeth, and their configuration—These characters agree in part, but not entirely, with those*

of the squalus maximus, *described by naturalists*; *whence it seems probable that this is of a different species, and not described by others—Resemblance between the position of its teeth and that of the teeth of the* squalus carcharias—*Opinion of Steno, that many of the teeth of sharks are of no use, proved false by Herissant—Observations of the author on the same subject—The size of sharks formerly considerably greater than that of those taken at present; as is proved by comparison of the fossil teeth of the former with the natural teeth of the latter—Fossil bones of animals of other kinds, when compared with the natural, exhibit the same disproportion—Some change in the configuration of the teeth of sharks, and an increase in their number, as the age of the fish increases—A reserve of teeth within their jaw to supply the place of such as are lost naturally or by violence—This provision not found in the Messinese shark, though its teeth in other respects resemble those of other sharks—Singular structure of the teeth in another species of shark.*

ſhark, and prodigious opening of the mouth —This, likewiſe, had not the teeth in reſerve which ſharks commonly have, though it appears very probable that it once had them—Apparent inutility of ſeveral rows of teeth in this fiſh, and in the Meſſineſe ſhark, as they remain buried in the fungous fleſh of the jaw—Further examination neceſſary before we decide on this ſuppoſed inutility—The argument from analogy, even when it ſeems moſt concluſive, may lead us into an error—Reaſons for denominating the above-deſcribed ſquali (ſharks), fiſhes, though that genus is placed in the claſs of amphibia by Linnæus.

WE ſhall proceed to treat of the fiſhery carried on in the ſame Strait for the ſea-dog, a fiſh appertaining to the genus of *Squali* (ſharks). The taking of this fiſh is accidental and not conſtant, as they have no periodical and fixed times of paſſage, are not very fit to be eaten, their fleſh being extremely hard, and the fiſhing for them being not a little dangerous, on account of

the larger ſpecies of ſharks, which will furiouſly attack men, and come up into the harbour of Meſſina. I was told by the people there that it was not long ſince a fiſherman, while ſwimming, had his leg bitten off by one of theſe fiſh, which being afterwards killed near the light-houſe, the leg was found entire as he had ſwallowed it in his ſtomach.

This fact will not greatly excite the admiration of thoſe who are acquainted with the voracity of theſe ſea-monſters. Such accidents are by no means unfrequent in ſeveral other parts of the Mediterranean. A few years ſince two perſons, who had gone into the ſea to bathe near Nervi and Chiavara, on the eaſtern coaſt of Genoa, were killed, and almoſt devoured by theſe ſharks. When I paſſed through Nice in the year 1783, I was preſented with the jaws of one of theſe fiſhes, in the ſtomach of which the body of a child was found entire, as the whole city was ready to certify. I ſtill preſerve theſe jaws, which have the

teeth

teeth in them; and the width to which they open is ſuch, that there can be no cauſe to doubt, for a moment, the truth of the fact aſſerted. Nicholas Steno, in his anatomy of the head of one of theſe ſharks, taken a few miles from Leghorn, obſerves that the tranſverſal diameter of the mouth, from one angle of the jaw to the other, was a Florentine ell; and that the other diameter, perpendicular to the former, contained four fifths of that ell. It cannot therefore be conſidered as wonderful that the bodies of men ſhould be found entire in the ſtomachs of theſe fiſh, as the opening of the mouth in that he obſerved was ſufficiently wide to receive them *.

In fact, beſides the melancholy accident which happened near Nice, we have an account ſtill more memorable given us by M. Brunnich in his *Ichthyologia Maſſilienſis*. I ſhall here give his own words; his relation being ſo circumſtantial that, however

* Elem. Myol.

extraordinary

extraordinary it may appear, it cannot be doubted.

" Capiebatur tempore quo Maſſiliæ fui, " piſcis ejus ſpeciei (ſqualus carcharias) " quindecem pedum longitudine. Major " duos abhinc annos occidebatur hærens in " littore urbes inter *Caſſidem* et *La Ciotat*. " Ventriculo tenuit duos ſcombros thynnos, " parum læſos, hominemque integrum cum " veſtitu omnino intactum; omnes, ut ap- " paruit, breve ante tempus devoratos. " Teſtes oculati, inter multos alios fuere " Dominus Garnier Secretarius Regis Gal- " liæ, qui præclara corallii rubri fabrica " urbis *Caſſidis* pauperes ſublevat multos; " ut et Rev. Dominus Boyer Parochus urbis " *La Ciotat* dictæ; uterque eruditione ſimul " ac fide ſatis pollentes *."

" A fiſh of this ſpecies (the ſhark) was " taken, while I was at Marſeilles, which " was fifteen feet long; and two years

* Ichthyol. Maſſ. p. 5, 6.

" before a much larger was killed near the " ſhore between the towns of Caſſis and la " Ciotat. The latter had in its ſtomach " two tunnies, little injured, and a whole " man, with all his clothes, untouched; " which ſeemed to have been devoured but " a ſhort time before. Among many other " eye-witneſſes of this fact were M. Gar- " nier Secretary to the King of France, who " gives employment to ſo many poor per- " ſons in his manufactory for working red " coral in the town of Caſſis, and the " reverend M. Boyer, Curate of the town of " La Ciotat; both eminent for their learn- " ing, and of unimpeached veracity."

This amplitude of mouth and throat, in the ſhark, beſides what it is naturally, is enlarged by the great elaſticity of the mandibular bones, which are of a cartilaginous nature. Thus ſerpents can ſwallow animals more bulky than themſelves, by conſiderably dilating their jaws and throat; and a viper will gorge a rat that is twice as thick as itſelf.

When

When I was at Meſſina I had not the ſatisfaction to ſee any of theſe ſea-dogs taken. But after my return to Pavia, the Abbate Grano was ſo obliging as to ſend me the bones and ſkin of one which was taken in that Strait; and which in ſome of its characters approached very near to the *ſqualus maximus* of Linnæus, though in others it was eſſentially different. As I do not know that this fiſh has ever before been deſcribed, I ſhall give ſome deſcription of it; principally directing my attention to the different rows of teeth it has, their configuration, and reſpective poſition in the jaw; and to ſome other circumſtances which I think moſt proper to fix the characters, and enable us to compare this fiſh with any other of a different ſpecies in the ſame genus.

The body, which is ſomewhat flat on the back, if meaſured from the point of the ſnout to the root of the tail, is eight feet nine inches long; and in its greateſt breadth five feet one inch and a half. The ſnout

or

or beak is pointed, the head round, the tranſverſal diameter of the open mouth, which is placed under the ſnout, ſeven inches and a half, and the perpendicular ſeven inches. The upper jaw is longer than the under. Both are rounded in the middle, but the former leſs than the latter.

Between the point of the ſnout and the eyes are two holes imperfectly rectangular; the larger ſide of which is horizontal, and ſeven lines long; and the leſs, which is vertical, three lines long. Theſe two holes paſs through the ſkin of the fiſh from ſide to ſide.

The eyes, which are rather large, are ſituated on the two ſides of the head. The ſpiracles, which are five, on each ſide, in the region of the neck, not very near to each other, are proportionate in ſize to the bulk of the ſhark, and increaſe in length as they approach the head. The anterior dorſal fin, which begins ſomewhat below the half of the body, is three inches long,

round

round at the extremity, and joined to a lanceolated appendage towards the tail.

Each of the two pectoral fins lies horizontally, is two feet long and one broad; and both have their origin immediately under the laſt ſpiracle, or that moſt diſtant from the head.

The ventral fins are each two inches in length; lanceolated at the top, with an appendage towards the tail. The anal fin is round at the extremity, two inches long, and ſituated a little below the region of the poſterior dorſal fin.

The tail is bilobed, or, more properly, bicuſpated; formed of two fins, ſemicircular within, and which terminate in a point. The upper fin is twenty-two inches in length.

The colour of the body is dark grey; but lighter on the under part.

The

The number of teeth in the lower jaw is ſixty-four; there is, however, in the middle of it an empty ſpace above an inch broad. The teeth form ſeparated groups, and the direction of the groups is tranſverſal, or from the outer to the inner part of the mouth. Every group is compoſed of four rows of teeth, except four of theſe groups, on the two ſides neareſt the vacuity abovementioned, and which contain five rows. Theſe teeth, which on account of their being in ſeparate groups are not contiguous, are extremely white, a little curved, with the points more or leſs inclined towards the gullet. The ſide next the outer part of the mouth is ſlightly convex, and the oppoſite ſide conſiderably more. The edges are angular and very cutting, but not ſerrated, and their points are very ſharp. The ſmaller teeth are placed in the root of the jaw; and are four lines long, and three and a half broad at the baſe; but, as they approach the middle, they become larger; and the largeſt are fifteen lines long, and ſeven and a half broad.

What

What has been ſaid of the groups, number, form, and ſize of the teeth in the lower jaw applies equally to thoſe of the upper; only that here we do not find the four groups with five rows of teeth; every group containing four, and not more. Theſe teeth, beſides, are ſtraight and not curved; or, if they have any curvature, it is extremely ſmall.

Some teeth of the firſt row, in both jaws, are broken; probably, in combats with other fiſh, or in ſeizing their prey. None of them are in ſockets; but they are all planted in the jaw, within a hard and fungous fleſh. It is to be obſerved that the firſt row projects out of the mouth, and is almoſt vertical to the plane of the jaw; but the other rows are nearly horizontal to this plane, having their points turned towards the gullet, and entirely or in part buried in the fungous fleſh, which, when I prepared the ſhark for the Muſeum, I removed ſo as to ſhew the teeth below it. I ſhall add, that in both jaws ſome teeth of the laſt row were, at the baſe, ſtill ſoft and

ſémi-cartilaginous; and the internal cavity was full of a whitiſh and very ſoft ſubſtance.

To aſcertain whether the fiſh which ſyſtematic naturaliſts call *ſqualus maximus* be the ſame with that I have now deſcribed, it will be neceſſary to compare this deſcription with that which other writers have given of the fiſh abovementioned.

Of theſe, the beſt we are in poſſeſſion of is that of Biſhop Grunner, publiſhed in the Memoirs of the Academy of Norway, which I have not ſeen, but which, according to the learned Brouſſonet, is very imperfect *.

Linnæus has made uſe of this deſcription, and characterizes the fiſh thus: "*Squalus* "*maximus dentibus caninis, pinna dorſali* "*anteriore majore.*—Habitat in oceano arcti-"co, victitans meduſis.—Corpus magnitu-"dine certans cum balænis, ſimillimum "ſqualo carchariæ, ſed abſque foraminulo

* Rozier Journal, an. 1785.

"ante aut poſt oculos. Pinna ani parva paulo "poſt regionem pinnæ dorſalis poſterioris."
GRUNNER.

But, according to Fabricius*, this huge animal not only feeds on meduſæ, but on porpuſes, and other ſmall cetaceous fiſh, which it ſwallows whole.

According therefore to Linnæus, the characters of the ſqualus maximus are, that it has canine teeth, the anterior dorſal fin larger than the poſterior; and the anal placed ſomewhat behind the region of the poſterior dorſal fin; and neither before nor behind the eyes has the ſmall hole which is found in moſt of the ſquali.

When theſe characteriſtics are compared with the deſcription given above, we find that they perfectly agree, except that the teeth which, in our fiſh, are lengthwiſe, angular and cutting, cannot properly be called canine; and that the ſmall hole above the

* Fauna Grœnlandica.

eyes

eyes is not found, according to Linnæus, or rather Grunner, in the ſqualus maximus.

The reality of theſe two characteriſtic marks in the preſent ſqualus may be confirmed by the example of another fiſh of the ſame ſpecies, but ſomewhat ſmaller, taken in the ſea of Marſeilles; when, in the year 1781, I went to that city, where fiſh may be procured in ſuch abundance, to collect ſpecimens of ſea-fiſh for the Public Muſeum at Pavia, which was then very deficient in ſuch ſpecimens. This fiſh, from the point of the ſnout to the beginning of the tail, was five feet and a half in length, and two feet ſeven inches thick. In both the characteriſtics above indicated, it was exactly ſimilar to the Meſſineſe ſqualus. The ſolid longitudinal, and extremely acute angles of the teeth were very viſible; as were likewiſe the two foramina, ſituated above the eyes, and below the point of the ſnout; from which latter they are diſtant three inches and a half, and from the eye one inch. When I procured this fiſh at

Marſeilles, which was immediately after it was caught, I introduced a probe into the two foramina, and found that it penetrated into the mouth.

Theſe two circumſtances, the angular poſition of the teeth, and, which is ſtill more deciſive, the two foramina in the temples, may be conſidered as diſtinctive and characteriſtic marks. The foramina, and the poſition of the anal fin, have been conſidered as ſo important by Brouſſonet, that in his excellent "Memoir on the different ſpecies of Sea-dogs or Sharks" he has founded on them a diviſion of theſe fiſh into three orders; the firſt including the ſpecies furniſhed with the anal fin and foramina in the temples; the ſecond, thoſe that have the anal fin without foramina; and the third, which have foramina without the anal fin. As the ſqualus maximus, according to Grunner, has no foramina, he has placed it in the ſecond order.

We muſt therefore be obliged to conclude,

clude, either that Grunner was an inaccurate obſerver, and that he overlooked the foramina and the angular teeth; or that the ſqualus he has deſcribed was a fiſh different from mine; which I am much rather inclined to believe, as I cannot eaſily imagine that two things which, when we examine a fiſh, are peculiarly conſpicuous, ſhould either have been not ſeen by him, or not noticed. I am the more confirmed in this opinion by the conſideration, that the ſqualus of Grunner, Linnæus, and Brouſſonet, is an inhabitant of the north ſeas; whereas that which I have deſcribed is a native of the Mediterranean; and frequently in the ſummer is taken in the Strait of Meſſina, where it ſometimes is found of a monſtrous ſize, and three or four times as large as that which was ſent to me.

In the deſcription of this fiſh I have ſaid, that only the firſt row of teeth are perpendicular to the plane of the jaw, the other rows being placed horizontally, with their points turned towards the throat, and bu-

ried within the fleſh of the jaw; and that none of them have their roots in ſockets, but that they are ſunk in this fleſh. This circumſtance, however, is not excluſive, as I find the ſame has place in the ſqualus carcharias; as we learn from Steno, who, after having remarked that "interiores (ordines "dentium) inferiora verſus recurvati, gin-"givarum molli et fungoſa carne ita deli-"teſcebant clauſi, ut non niſi reſectis gin-"givis in conſpectum prodirent"——"the "inner (rows of the teeth) are bent down-"wards, and are ſo encloſed in the ſoft and "fungous fleſh of the gums, that, unleſs "the latter be cut away, they are not "viſible"——adds—"Cui uſui dentes ita "incurvatos natura deſtinarit non perſpi-"cio, cum carnes intra ſepulti eſcæ com-"minuendæ nulla ratione potuerint inſer-"vire. Retinendæ predæ, ne diffugiat, for-"ſitan et diffringendæ majori, quam quæ "ventrem ſubire poſſit, primi ordinis inſer-"viunt: reliqui vero, niſi materiæ neceſſi-"tate facti, non video cujus gratia ſint con-"fecti."—"For what uſe the teeth thus

"bent

" bent were intended by nature I cannot
" diſcover; ſince they are ſo buried within
" the fleſh, that they cannot ſerve for grind-
" ing the food. The teeth in the firſt row
" may, perhaps, be deſigned to prevent the
" prey from eſcaping, or to divide it when
" too large to be received into the ſtomach;
" but why the others were formed I do
" not ſee, unleſs we ſay, that they have
" been produced by the neceſſary action of
" matter."

According to this celebrated anatomiſt, therefore, the numerous teeth which in the jaw of the ſhark are covered with a ſoft and fungous fleſh, are of no uſe to the fiſh. But ichthyologiſts are not ignorant, that Heriſſant was of a different opinion. He found, after a very careful examination of ſeveral jaws of ſharks, that the teeth, more or leſs covered with fleſh, are teeth of reſerve, to ſupply the place of thoſe of the firſt row, ſhould they chance to be loſt; in which caſe, theſe which lie below riſe out of the

fungous fleſh, and take the place of thoſe that are wanting*.

As there was in the Public Muſeum a ſmall ſhark, and ſome ſeparate jaws of that fiſh, I could not refrain from examining them, and making ſome comparative obſervations between the teeth in them and thoſe of the ſhark from Meſſina, as they had nearly the ſame poſition.

The ſhark of the Muſeum, which had been brought the preceding year from the coaſt of Africa by the Abbate Roſa, one of the two keepers of that royal eſtabliſhment, was but a pigmy, when compared with ſome full-grown ones of the ſpecies, its length being only about ſix feet, and its greateſt breadth three feet four inches. The firſt row of teeth in the upper jaw ſcarcely projected out of the mouth, with a ſlight curvature of the points towards the inſide

* Mem. de l'Acad. Roy. 1749.

of

of the jaw. The ſecond row was more bent towards the throat. The other rows lay flat on the jaw, and were the greater part of them ſunk within it and covered. The length of the larger teeth is four lines and a half, and their breadth three and a half. The ſame appearances preſent themſelves in the different rows of teeth in the lower jaw, except that they are ſmaller, and not ſerrated like thoſe of the upper jaw. But the dryneſs and hardneſs of the jaws in this ſhark, the mouth of which it was improper to damage, as it belonged to the Muſeum, prevented me from cutting away the fungous fleſh, laying bare the teeth, and examining them in the ſame manner I had thoſe of the ſhark of Meſſina.

This examination, however, I was at liberty to make in the two detached jaws. I therefore, in order to ſoften them, ſoaked them for ſome time in water; and, as they were ſeparated from the fiſh, I was enabled to handle them as I pleaſed, and, in conſequence, made the following obſervations:

The

The teeth of the upper jaw are triangular, flat on the outer ſide, and very ſlightly convex on the inner, ſerrated at the edges, in length eight lines, and in breadth, at the baſe, ſix lines; I mean thoſe which are near the point of the jaw, for thoſe towards the roots are much ſmaller. There are four rows of them. The teeth of the firſt row riſe almoſt perpendicularly to the plane of the jaw, but with their points inclined to the ſides. Four of them are wanting; and though their place is not ſupplied by teeth from the ſecond row, it is obſervable that four of the latter teeth, immediately correſpondent to thoſe that are loſt, have raiſed themſelves and puſhed forward towards the firſt row; whence there is every reaſon to believe that, in time, they would have occupied their place. This is the more probable, as all the other teeth of the ſecond row are extended almoſt horizontally, with their tops buried in the fungous fleſh, as are alſo thoſe of the third and fourth rows; with this kind of regularity, that the teeth of the ſecond row reſt on thoſe of the third, and

thoſe

thoſe of the third on the fourth. On diveſting, in part, the jaw of the fungous fleſh, the teeth of the fourth row are found to be ſoft, or, at leaſt, not to have the hardneſs of the others.

Proceeding to examine the teeth of the lower jaw, I found no other difference between them and thoſe of the upper, except that they are proportionally ſmaller: they reſemble them in all other particulars; among which it is not to be omitted that their edges are ſerrated; and that, except the firſt row, they are all more or leſs covered by the fleſh of the jaw. It is here to be obſerved, that two of the teeth of the firſt row have been broken off at the root, and the thin long cavity in which they were implanted is viſible; but, in part, filled up by two teeth of the ſecond row, which have come into the place of thoſe that are wanting.

I was now ſatisfied that the teeth of the ſecond row, which are bent towards the throat,

throat, are not merely "produced by the neceſſary action of matter," as Steno has ſuggeſted, but deſigned by Nature to ſupply the place of thoſe of the firſt row, when they may chance to be loſt, as was firſt diſcovered by Heriſſant; and I flatter myſelf I am the firſt who, ſince he wrote, has confirmed his ingenious and noble obſervation. And as the teeth of the third and fourth row, as well as thoſe of the ſecond and firſt, are adherent to the fungous fleſh, which is moveable in the anterior parts of the mouth, I have no difficulty in believing that, when any of the teeth of the ſecond row are broken after they have entered into the firſt, thoſe of the third ſupply their place, which may be followed by thoſe of the fourth: ſo that the teeth of thoſe three rows may be conſidered as ſupplementary to thoſe of the firſt.

While employed on the examination of theſe two jaws, and conſidering their ſize, which is, in fact, that of the open mouth of the ſhark to which they belonged, being thirty inches and a half in circuit, not-

withſtanding the ſmall ſize of the teeth, of which, as we have ſeen, the largeſt are only eight lines long and ſix broad, I could not but reflect how prodigiouſly capacious muſt be the mouth, and conſequently how vaſt the ſize of the body of thoſe ſharks, the teeth of which, improperly denominated *gloſſopetræ*, are found in a foſſil ſtate. I have ſome of theſe, one of which is thirty-two lines thick at the baſe, and thirty-five high. When examined with the utmoſt care, nothing can more reſemble the ſerrated teeth of the Imperial Muſeum. If, therefore, the teeth of this fiſh, which is ſix feet long and three thick, are only three lines and a half broad, and four and a half high, how much more prodigious muſt have been the ſize of the ſhark which left this gigantic tooth in the earth! How tremendouſly wide muſt have been the opening of its mouth and jaws!

It muſt here be recollected, that I have tacitly ſuppoſed the gloſſopetra to have been one of the larger teeth of the ſhark, or thoſe

of

of the upper jaw towards its point, and which project from the mouth, as in every other part of the jaw they are leſs. Should the gloſſopetra have been one of the leſſer teeth, the proportion muſt have been much increaſed; for had a foſſil tooth been found from among thoſe near the middle of the upper jaw, there can be no doubt but its ſize would have been much greater.

Though ſharks of an enormous ſize have been taken in our times, none have been found to have the extraordinary dimenſions which muſt be inferred from the meaſure of this foſſil tooth. Nor ought this to excite our wonder ſo much as may be ſuppoſed. Teeth and bones of animals of other kinds have been found of a ſize which clearly proves that individuals have exiſted beyond compariſon larger than thoſe of the ſame ſpecies which at preſent live and multiply in the known parts of the globe. Such are, for example, elephant's tuſks, of a ſize much larger than that of any natural ones brought us from Aſia or Africa. On this

fubject the Abbate Fortis has written a learned and truly inſtructive memoir, which well merits peruſal, entitled, "*On the Bones of* "*Elephants found in the Mountains of Ro-* "*magnano in the Veroneſe**." In the year 1791 there was found in the Po, oppoſite Arena, fifteen miles from Pavia, the head of a deer (*Cervus dama*) which I conceived to merit a place in the rich collection of foſſil bones in the Public Muſeum. It is extremely well preſerved, and was found in the natural ſtate of bone, with its teeth, and wanting a horn. Its value conſiſts in its ſize; it being more than twice and a half larger than the heads of animals of the ſame ſize; as I proved by comparing it with the heads of deer which had reached their full growth in a ſtate of liberty. The horn it bears is of proportionate ſize. The year after I procured for the ſame cabinet, a prodigious thigh-bone of an elephant, found in the ſame place; where, a ſhort time before, a ſkull had likewiſe been found, which had every appear-

* Dell' Oſſa d'Elenfanti de' Monti Romagnano nel Veroneſe.

ance

ance of being that of an ox, but was of an enormous ſize.

With reſpect to ſharks, it may, perhaps, be true, that they would ſtill grow to the vaſt ſize which we have ſhewn they attained to in former ages, were they not prematurely killed by fiſhermen and mariners, on account of the utility derived from their fleſh, their fat, and their ſkin. We likewiſe know that the inſatiable eagerneſs of theſe voracious fiſh for the bait prepared for them, renders them eaſily taken. Thus, when whales were firſt fiſhed for in the northern ſeas, they were frequently found of an aſtoniſhing ſize; but ſince the fiſhery has been conſtantly repeated every year, they are never met with of ſuch extraordinary dimenſions.

Linnæus tells us that the ſqualus carcharias has ſix rows of teeth, and that theſe teeth are ſerrated. At firſt view this ſeems not to agree to the animal I obſerved, ſince, as we have ſhewn, that has four rows, and not ſix; but as we have ſeen that the teeth of the

the fourth row are ſoft, it is very poſſible that their germs may have begun to develop after thoſe of the anterior rows, and hence we may preſume that other rows may afterwards appear. In like manner, though in the ſmaller ſharks the teeth of the lower jaw are not ſerrated, they are in thoſe of a larger ſize, of which I examined the jaws. We may therefore conclude that, in ſharks, teeth are in time produced which they had not when young, and that theſe teeth are liable to changes, ſuch as is that of becoming ſerrated. Thus, the teeth included in ſockets in the long bony ſnout of the ſaw-fiſh *(ſqualus priſtis)* do not appear till the animal has arrived at a certain age.

The moſt remarkable circumſtance relative to the ſhark, and which ſeems conſtant in all its different ages, is the privilege it poſſeſſes of re-acquiring, in a certain manner, the teeth it has loſt. But is this privilege confined to the ſhark alone, or enjoyed by other fiſh? It certainly appears to extend to ſuch as have, firſt, ſeveral rows of teeth; ſecondly, thoſe

teeth not infixed in the bone of the jaw, but in the ſoft fleſh of it; and thirdly, the teeth of the hinder rows turned towards the throat, and covered with the fleſh of the jaw. Theſe three circumſtances concur in the *ſqualus carcharias* (the white ſhark); and, as they likewiſe concur in the ſqualus of Meſſina, it ſhould ſeem that the latter muſt likewiſe enjoy the ſame privilege. But this is not verified by obſervation. Several teeth, as I have already ſaid, are wanting in the firſt row; but the correſponding, in the ſecond, are not in the leaſt raiſed, but are ſtill bent backwards, preciſely like the reſt of the ſame row.

Before I conclude theſe remarks, which I have conſidered as of ſufficient importance to prove intereſting to my readers, I ſhall give a brief deſcription of the very ſingular dentature of two jaws ſimilar to that of the ſqualus of Meſſina, which were brought with a number of exotic fiſhes from Holland, and appear to have belonged to a very large ſqualus, but of a ſpecies hitherto unknown;

at

at leaſt I do not find teeth of a ſimilar ſtructure deſcribed by any writer.

The opening of the jaws is full three feet and a half in circuit, and conſequently large enough to receive a man of middling ſize lengthwiſe. The upper jaw, which is rounded in front, has five rows of teeth. The firſt and ſecond row repreſent ſo many combs as they contain teeth; only with the difference that thoſe neareſt the baſe, and that in the middle of the jaw, are ſmaller than the others. Every one of theſe combs is dentated on each ſide with ten teeth, extremely ſharp at the point, bent towards the baſe of the jaw, and ſucceſſively larger in proportion as they approach the middle. The upper ſide projects from the mouth, and the lower looks downwards: the two ſides are not parallel, but, with the body of the comb, form a plane narrowing towards the baſe of the jaw, and enlarging on the contrary ſide. The combs (or the teeth of the firſt and ſecond row) are contiguous, having between them only an obtuſe-angled

ſpace toward the top, and by their middle, lengthwiſe, are ſolidly attached to the ſemi-cartilaginous ſkin of the jaw.

Such are the principal peculiarities I remarked in the two firſt rows of teeth. But under the ſecond row there is a third; under that a fourth, and under that a fifth. Each of theſe three rows of teeth forms, in like manner, a dentated comb, with ten teeth, ſimilar to thoſe of the two upper rows, except that theſe combs are only dentated on one ſide, while the other is firmly fixed in the fleſh of the jaw. Except the firſt row, therefore, the others are deeply buried under a ſtratum of fungous fleſh, which muſt be taken away to render them viſible.

I omit to mention a multitude of ſmall teeth, long, ſmooth, and obtuſe, ſituated at the roots of the jaw, and under the pectinated teeth.

Theſe teeth, then, are diſpoſed in five rows, which number five, being multiplied by thirteen,

teen, for the whole jaw, produces ſixty-five: the number of pectinated teeth.

Of theſe one of the largeſt in the firſt row is wanting, being entirely detached from the jaw. This loſs could not have been recent, when the fiſh was taken, as the fungous fleſh had formed a ſcar over the place it had occupied, producing an angular elevation of ſome thickneſs. If, therefore, the ſecond row of theſe teeth, and the ſame may be ſaid of the other lower rows, had been deſigned by nature to ſupply the deficiencies that might happen in the firſt, it is evident that the tooth below would have occupied the place of the tooth wanting, or at leaſt would have raiſed itſelf up and approached nearer to it. The fact however is, that this tooth, which we might have ſuppoſed to be formed as a ſubſtitute, is by no means ſuch, but ſtill continues in the ſame poſition with the others, and covered in the ſame manner with the fungous fleſh.

In Plate XI. I have given the figure of

the upper jaw, with the pectinated teeth. The reference A. indicates the tooth that is wanting.

The lower jaw, which is ſhorter than the upper, and ſharp in the middle, is provided with a dentature entirely different. Every tooth is full two-thirds ſmaller than thoſe formed like combs, is bicuſpated, tricuſpated, or quadricuſpated, there being no conſtant rule, and the points are turned to the ſides of the jaw. Some of theſe teeth project, as they appear in Plate XI. in which the lower jaw is repreſented as joined to the upper. They are in three rows, and every row contains, in the circuit of the jaw, fourteen teeth. Thoſe of the ſecond and third rows, as uſual, lie flat, and are covered with the fungous fleſh. Thoſe of the firſt row are in a poſition almoſt perpendicular. They are all deeply rooted in the fleſh. In this jaw, likewiſe, the firſt row is not complete, ſeveral teeth being wanting. Their place, however, has not been ſupplied by thoſe of the ſecond row; nor is there any appear-

appearance indicatory of ſuch a ſubſtitution, as they all lie flat in the mouth like the others of the ſame row.

From what has been obſerved of this fiſh, of the ſpecies of which I am ignorant, and of the other taken near Meſſina, which from ſome of its characteriſtics has been confounded with the *ſqualus maximus*; it is evident, that though their teeth are found in preciſely the ſame circumſtances with thoſe of the teeth of the *ſqualus carcharias*, as obſerved both by Heriſſant and myſelf, yet they have not received from nature the privilege of repairing the loſs of their teeth by the ſubſtitution of thoſe that remain.

But if theſe teeth thus turned towards the throat, and enveloped in fleſh, are not placed there in reſerve, and intended to ſupply the place of thoſe that may be loſt, naturally or by violence, what can be their uſe? It is certain that, if during the whole life of the animal they remain in the mouth in the ſame poſition, they can be of no ſervice to

them with reſpect to their prey, as they are unfit either to ſeize it or grind it. In like manner they cannot be offenſive weapons againſt their enemies, in the combats in which it is known theſe fiſh are continually engaged. Shall we then adopt the improper ſuggeſtion of Steno, and aſcribe their formation merely to "the neceſſary action of matter?"

I am far from wiſhing to give a haſty judgement relative to the ends nature has had in view. Of many of them we are profoundly ignorant, and many, it is probable, we ſhall never diſcover. Yet there are others ſo apparent that we cannot be miſtaken. There cannot be a doubt, for example, that the teeth in moſt animals are an offenſive and defenſive weapon, beſides ſerving for the trituration and maſtication of their food; and that in others their office is to ſeize and hold faſt the prey till it ſhall be ſwallowed and paſs into the ſtomach. Sharks, like an infinite number of other fiſh, do not maſticate; but uſe their

teeth to ſeize their prey, employing thoſe of the firſt row, which when they are loſt have their place ſupplied by thoſe of the lower rows, ſuch being their deſtination. In the two ſpecies which I have deſcribed there is a difference; the teeth of the firſt row, which project from the mouth, being alone adapted to ſeize and prevent the eſcape of the prey. Theſe, however, when they fall out naturally, or are broken off by violence, are not reſtored, ſince the teeth which would ſupply their places in the common ſhark have not the ſame property in theſe ſpecies of fiſh. The teeth, therefore, of the ſecond and following rows are of no ſervice to theſe animals, with reſpect to the prey they may take or attempt to take. But ſhall we therefore conclude that they are entirely uſeleſs? I will not be ſo preſumptuous as to entertain ſuch a thought. The lower rows of the teeth of the common ſhark were once ſuppoſed uſeleſs, until by careful and accurate examinations of different jaws their real and truly important uſe was diſcovered. Of the ſpecies now in

queſtion

queſtion I have only ſeen three jaws: perhaps, had I an opportunity to examine more, eſpecially ſuch as had belonged to fiſh of different ages, I might be able to elucidate this, at preſent, difficult queſtion.

In the mean time, what has been now obſerved may teach us how cautious we ought to be in judging from analogy. What greater analogy, not to ſay identity, can be conceived than that between the circumſtances attending the lower rows of teeth in the common ſhark, and thoſe of the ſame rows in the two ſpecies we have laſt deſcribed? How natural, therefore, was the concluſion, that if theſe rows were intended to ſupply the place of ſuch as might be loſt or broken, in the former animal, they had the ſame deſtination in the latter? Yet has obſervation ſhewn that this inference is falſe. Whence it appears, that by truſting to analogy we may be ſometimes led into error; by attributing, as in the preſent caſe, to one ſpecies of a genus what is only true of another.

In theſe experimental enquiries I have conſidered the *ſquali* as fiſhes, properly ſo termed, though Linnæus has taken them from that claſs, and placed them in that of amphibia, in which he has alſo the rays, lophii or ſea-devils, lampreys, &c. becauſe, according to him, theſe genera have perfect lungs. But it has been demonſtrated by more accurate obſervations made by M. Vicq-d-Azyr, that they have not theſe viſcera; of which I have myſelf been convinced with reſpect to ſeveral ſpecies of rays, and other fiſh that had been improperly ſuppoſed to belong to the claſs of amphibia.

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FIG.I.

FIG.II.

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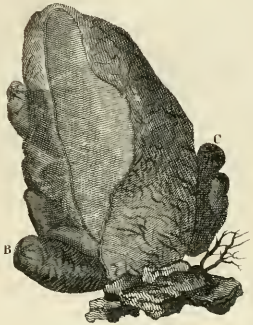
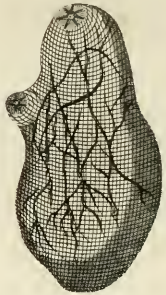


FIG.IV.

FIG.V.



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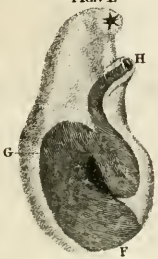
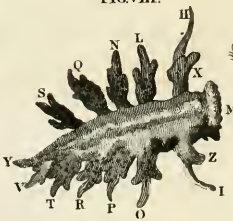


FIG.VII.

FIG.VIII.



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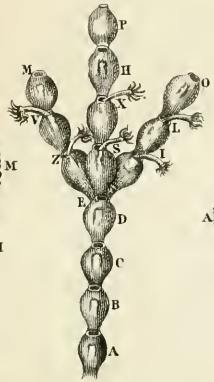
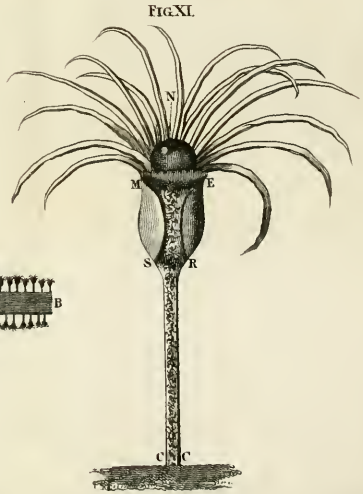


FIG.X.

FIG.XI.



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